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Geology for planning in De Witt County, Illinois

Cathy S. Hunt and John P. Kempton

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Number 83
August 1977

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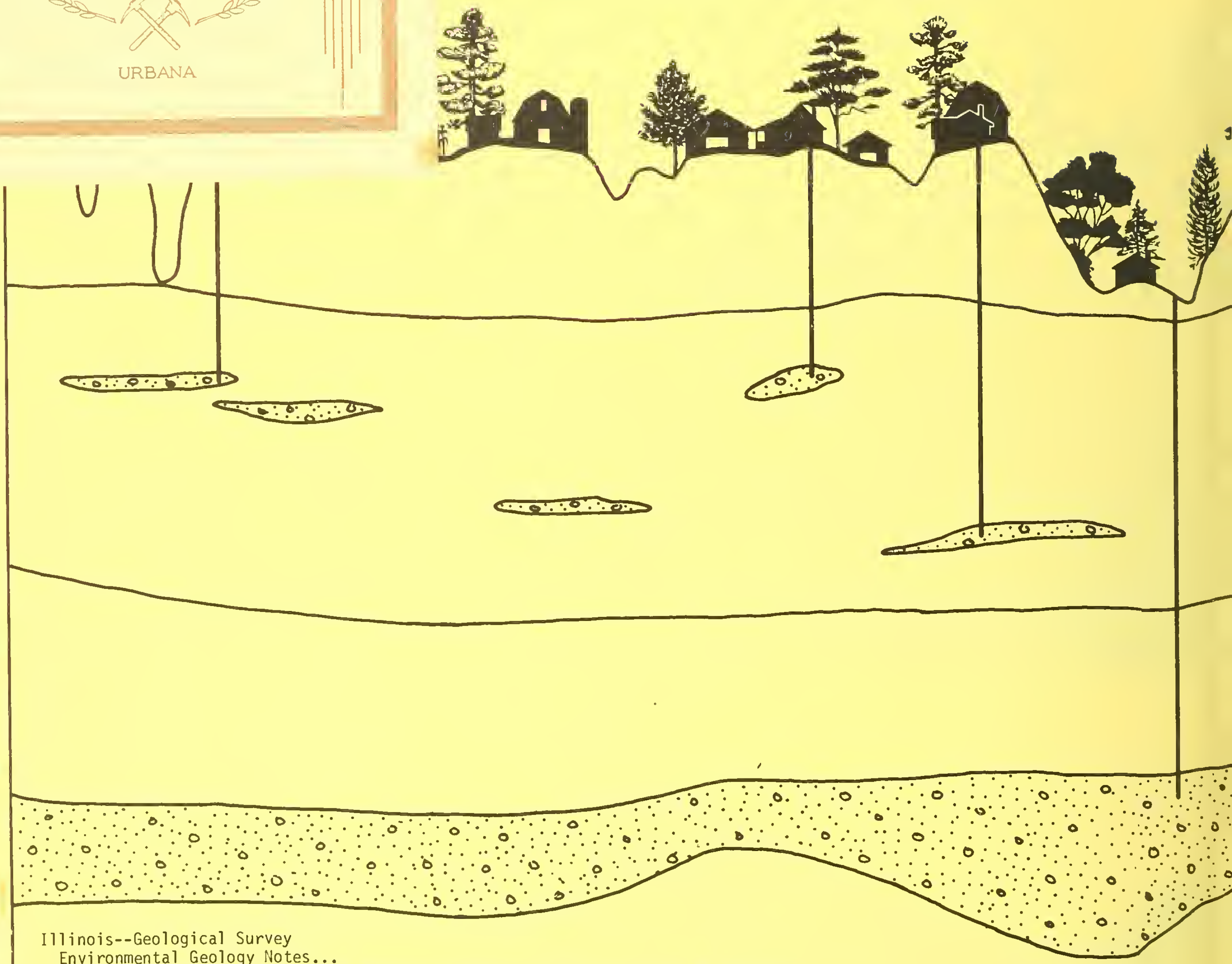

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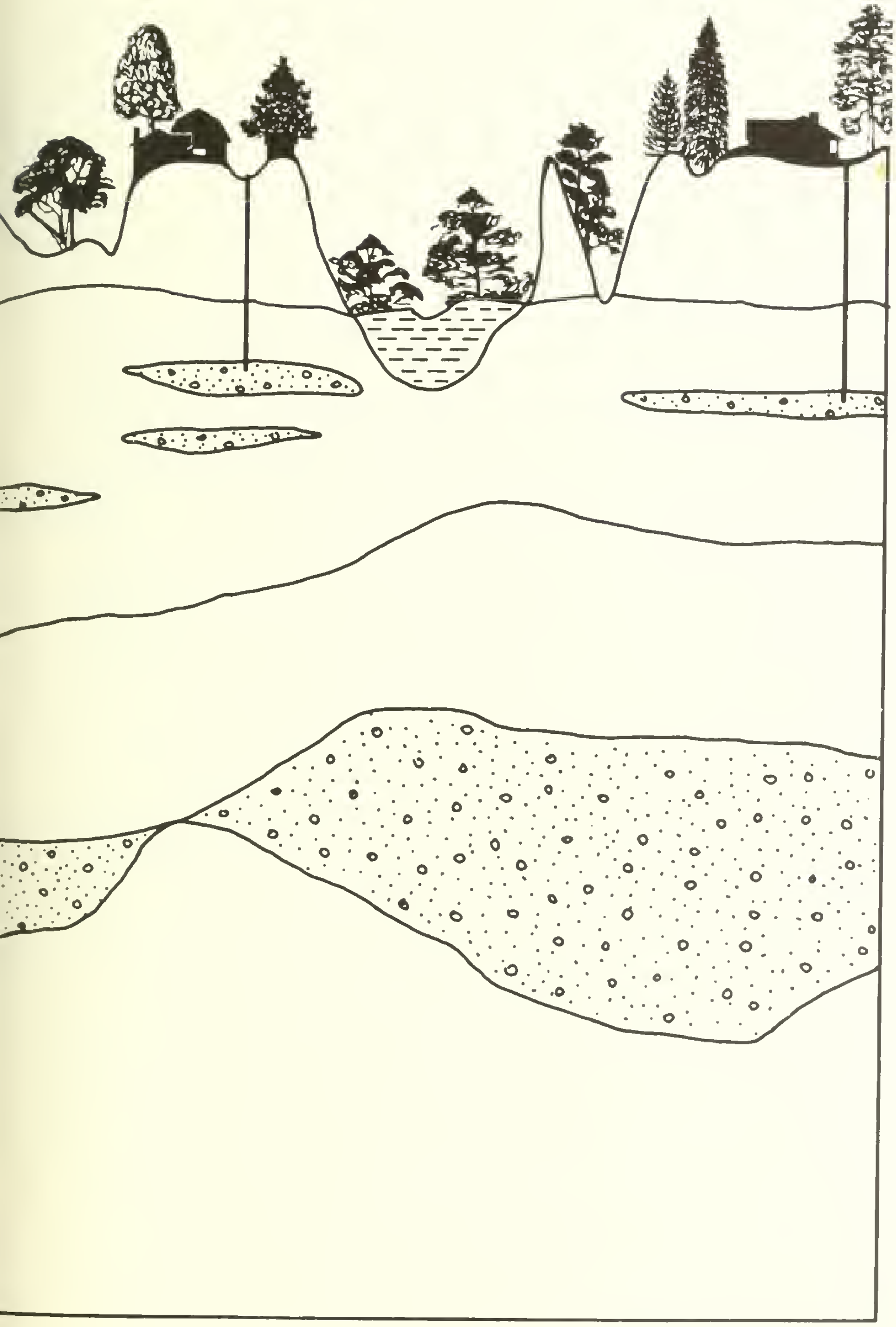

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Geology for planning in De Witt County, Illinois

Cathy S. Hunt and John P. Kempton

ABSTRACT

Most of the land in De Witt County is in crop production, and the economy of the region is based on agriculture. Illinois Power Company is constructing a nuclear power plant east of Clinton; a dam that will form a two-armed cooling lake on Salt Creek and North Fork is almost completed. Further industrial, commercial, and residential development is expected to result from construction of the power plant and lake.

Important considerations for land-use planning are the geologic characteristics and resources of the county. The land surface of De Witt County is underlain by unconsolidated, mainly glacial drift deposits up to 400 feet (122 m) thick. The thick deposits occur in the Mahomet Bedrock Valley, which underlies most of the county. The unconsolidated deposits consist primarily of glacial till, which is covered by loess on the upland. The unconsolidated deposits in the valleys consist of till, glacial outwash, and alluvium. Sand and gravel within the alluvium, glacial outwash, and till is the main source of small ground-water supplies in the county. Sand and gravel deposits up to 150 feet (46 m) thick, which are found at the base of the glacial drift in the Mahomet Bedrock Valley, yield large ground-water supplies. In the glacial outwash deposits along Salt Creek, sand and gravel is mined for building material. The principal surface-water resources of De Witt County are Salt Creek and its tributaries.

Oil has been produced from two fields in Silurian, Devonian, and Mississippian rocks at depths less than 1200 feet (366 m). No coal is mined in De Witt County; however, reserves of coals are present in the Pennsylvanian bedrock. The Springfield (No. 5) Coal is 450 to 500 feet (137 to 152 m) below the surface. The organic deposits in the glacial drift are the source of small amounts of natural gas.

In spite of poor drainage, the majority of the soils in the county are productive. Much of the upland is suitable for solid-waste disposal by landfill; the sloping areas and the bottomland are generally unsuitable. Some slope instability along the valleys and poorly drained soils are the major constraints for construction.

ACKNOWLEDGMENTS. The authors of this report were assisted by a number of other staff members of the Geological Survey. John M. Masters prepared the section and map on sand and gravel resources. Frank B. Sherman, Jr., prepared the map of solid-waste disposal conditions. Janet L. Phelps and Paul B. DuMontelle prepared the section and map on engineering conditions and the map of poorly drained soils. Roger B. Nance prepared the section on coal, and Richard H. Howard, the section on oil and gas.

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introduction

De Witt County is in the heart of east-central Illinois, a highly productive agricultural region (fig. 1). Most industries in the county are small, and most are related to agriculture. Within 30 miles (48 km) of the county's borders are four large urban areas—Decatur to the south, Springfield to the southwest, Champaign-Urbana to the east, and Bloomington-Normal to the north. Rolling topography relieves the flatness of the county's surface, particularly on the western margin of the county and along the two main streams—Salt Creek, which flows westward across the central part of the county, and North Fork, which flows southward into Salt Creek. Another large stream, Kickapoo Creek, crosses the northwestern corner of the county; Long Point Creek, a tributary of Kickapoo Creek, flows west across the northern edge.

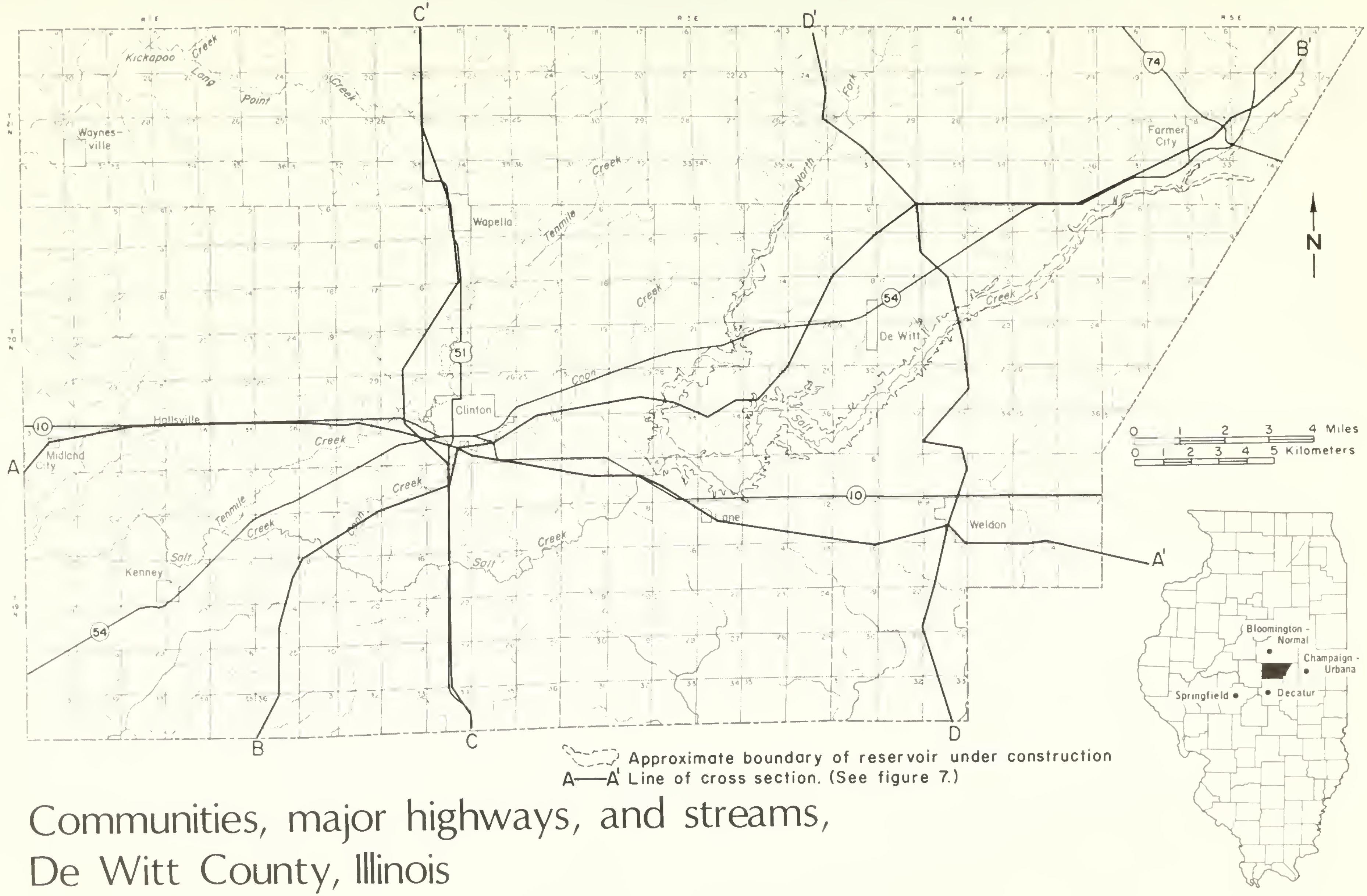
In 1970 the total population of the county was 16,975 (U.S. Department of Commerce, 1972). The county seat, Clinton, with a population of about 8000, is the largest community, followed by Farmer City, which has a population of slightly more than 2000. All other communities in the county have populations less than 1000.

Purpose and scope

This study was initiated in 1972, in part as a response to the selection of a site east of Clinton for a nuclear power plant to be built by Illinois Power Company on the upland at the intersection of North Fork and Salt Creek. A dam on Salt Creek in Section 5, T. 19 N., R. 3 E., will form a lake with arms on Salt Creek and on North Fork at an estimated pool level of 690 feet (210 m) above mean sea level. It is anticipated that the power plant and a lake that will provide recreational facilities will stimulate further industrial, commercial, and residential growth in the area.

In addition to the selection of the power plant site, the geologic conditions and mineral resources described in this report also have an important bearing on land use and regional planning in De Witt County. The Mahomet Bedrock Valley, which underlies De Witt County, is of special regional interest because it contains a thick sequence of glacial drift, including the principal sand and gravel aquifer of east-central Illinois, the Mahomet Sand Member, which is a potential source of large ground-water supplies (Stephenson, 1967).

Included in the report are maps of De Witt County showing surficial deposits; ground-water resources; sand and gravel resources; coal, oil, and gas resources; and geologic conditions that affect solid-waste disposal and general construction. The maps are not intended to be used to predict conditions at specific



Communities, major highways, and streams, De Witt County, Illinois

Figure 1

sites; rather they are guides to the resources and geologic conditions in the county. The scale, and hence the size, of the maps are limited first by the size of the page on which the map can be printed economically and second by the quantity and accuracy of available geologic data. Map scale is also affected by special problems in mapping geologic boundaries; it would be convenient if natural geologic boundaries were precise lines, but usually they are gradational. The boundary lines shown on a geologic map may actually represent a gradual change, over a few feet or a few hundred feet, from one type of material to another. Available data may not allow the precise positioning even of distinct boundaries. Therefore, photographic enlargement of a geologic map is not an acceptable method for obtaining maps at a larger scale because enlargement introduces inaccuracies that may lead to improper interpretations, particularly near boundaries.

Methods

The geologic names used in the figures and text were adopted by Willman and Frye (1970) and Johnson, Gross, and Moran (1971) and are given in figure 2. Figures 3, 4, and 6 were completed first and form the basis for many of the other maps. The most basic map, figure 6, which shows geologic materials to a depth of 20 feet (6 m), was prepared by collecting and plotting all the subsurface data on a base map at a scale of 1:62,500. The process included interpreting a map of agricultural soils in the county (Smith and Smith, 1940), studying Illinois State Geological Survey files containing logs and samples of foundation borings and water wells, and examining available geophysical data. The other two basic maps, which show bedrock topography (fig. 3) and drift thickness (fig. 4), were delineated by using well data, geophysical logs, and maps of surface topography. Figure 6 was used to prepare maps of near-surface resources and suitability of land for waste disposal and construction, and figures 3 and 4 were used to map the position of the Mahomet Sand Member. The maps of bedrock resources were derived from existing maps. Skylab 2 photography was a source of some general information used in mapping.

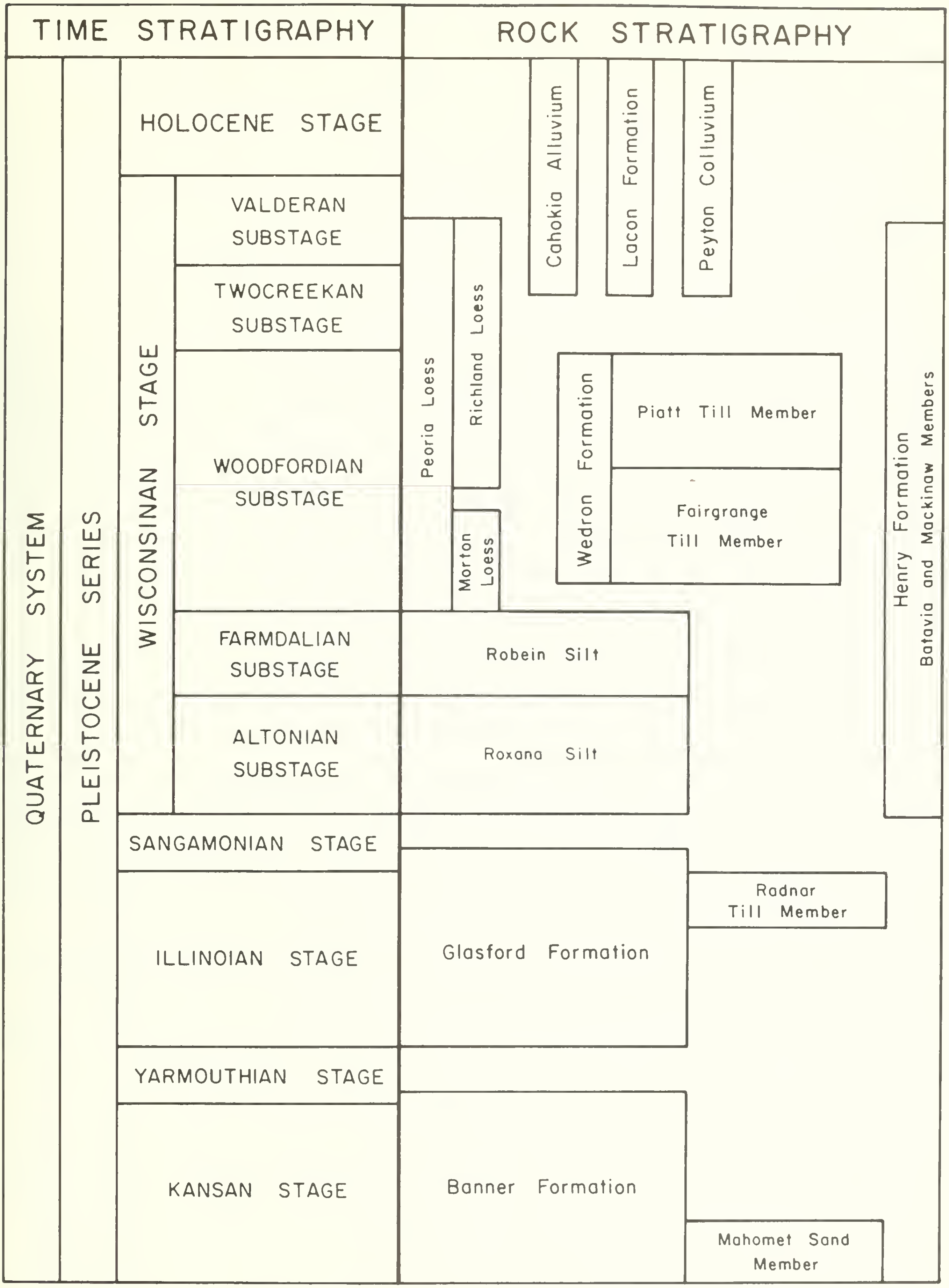


Figure 2. Classification of the Pleistocene deposits of De Witt County, Illinois

geology

The characteristics of the land surface in De Witt County, including the topography and the nature of the unconsolidated surficial materials, are mainly the results of the action of glacial ice and flowing water. The stratified bedrock lying below the unconsolidated surficial deposits at depths ranging from 50 to 400 feet (15 to 122 m) correlates little with the present landscape; however, the topography of the buried bedrock surface (fig. 3) has a direct bearing on the thickness of the drift deposits (fig. 4). Where the elevation of the bedrock surface is low along major ancient valleys, the glacial deposits are thick and contain substantial amounts of the sand and gravel that filled these valleys; where the bedrock surface is high, the drift deposits are generally thin and contain less sand and gravel.

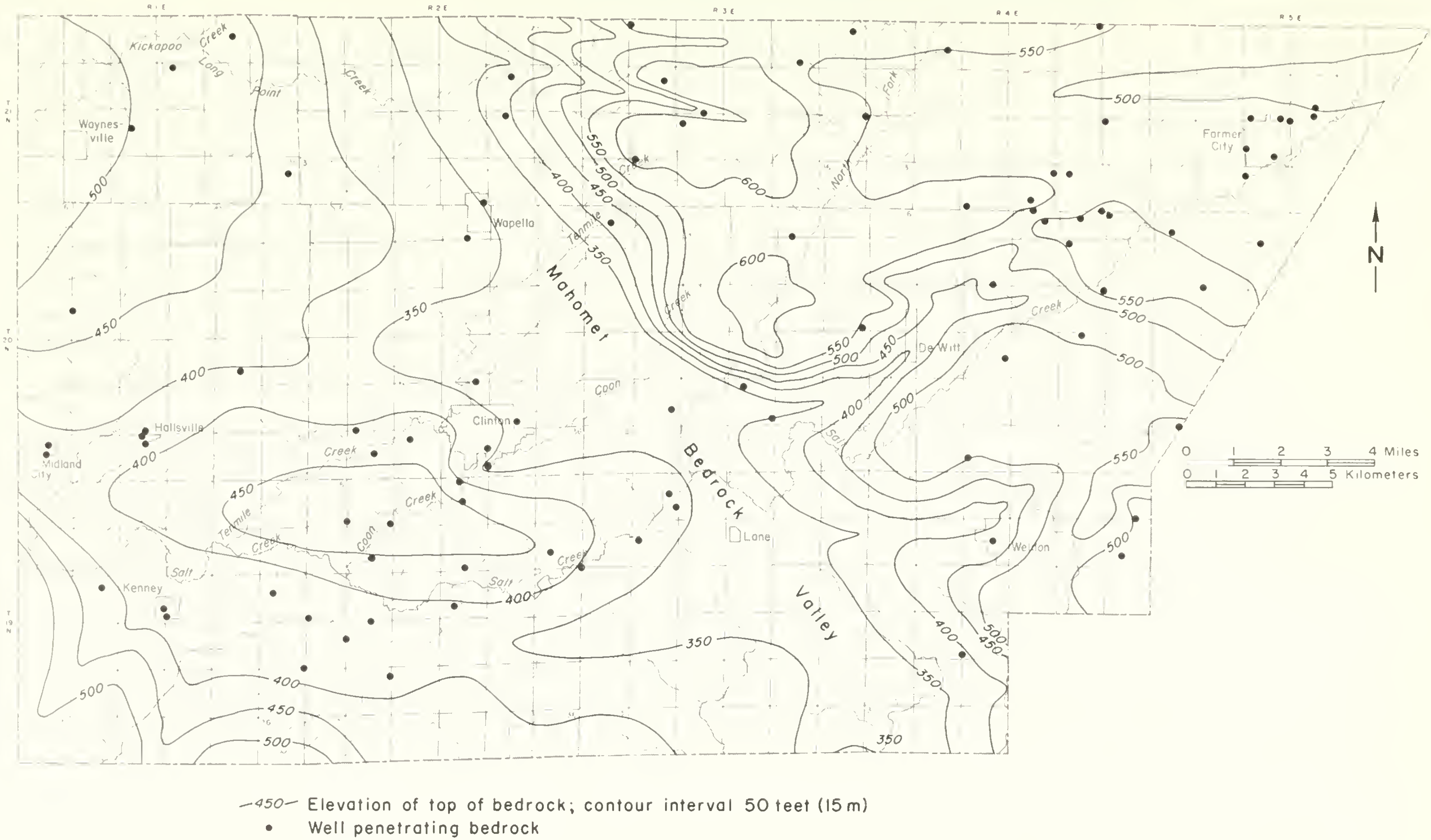
Bedrock geology

Directly beneath the glacial deposits (Pleistocene Series) are the Bond and Modesto Formations of the Pennsylvanian System, composed primarily of shale and sandstone with some thin but significant beds of limestone and coal (Willman et al., 1967). Below the Pennsylvanian rocks, which range in thickness from about 400 to 800 feet (122 to 244 m) in De Witt County, is a thick sequence (some 5000 feet [1524 m]) of interbedded shales, sandstones, limestones, and dolomites representing all earlier Paleozoic periods. The materials there include rocks of Silurian, Devonian, and Mississippian age from which oil and gas have been produced. The granite basement is encountered at a depth of 5000 to 6000 feet (1524 to 1828 m).

The Pennsylvanian System was buried under an estimated 3000 feet (914 m) of younger strata that subsequently eroded; the result was a landscape with deep valleys incised in the bedrock. One of the major bedrock valleys in Illinois, the Mahomet Bedrock Valley, underlies a large portion of De Witt County. Figure 3 illustrates what is believed to be the appearance of the landscape carved in the bedrock beneath the glacial deposits.

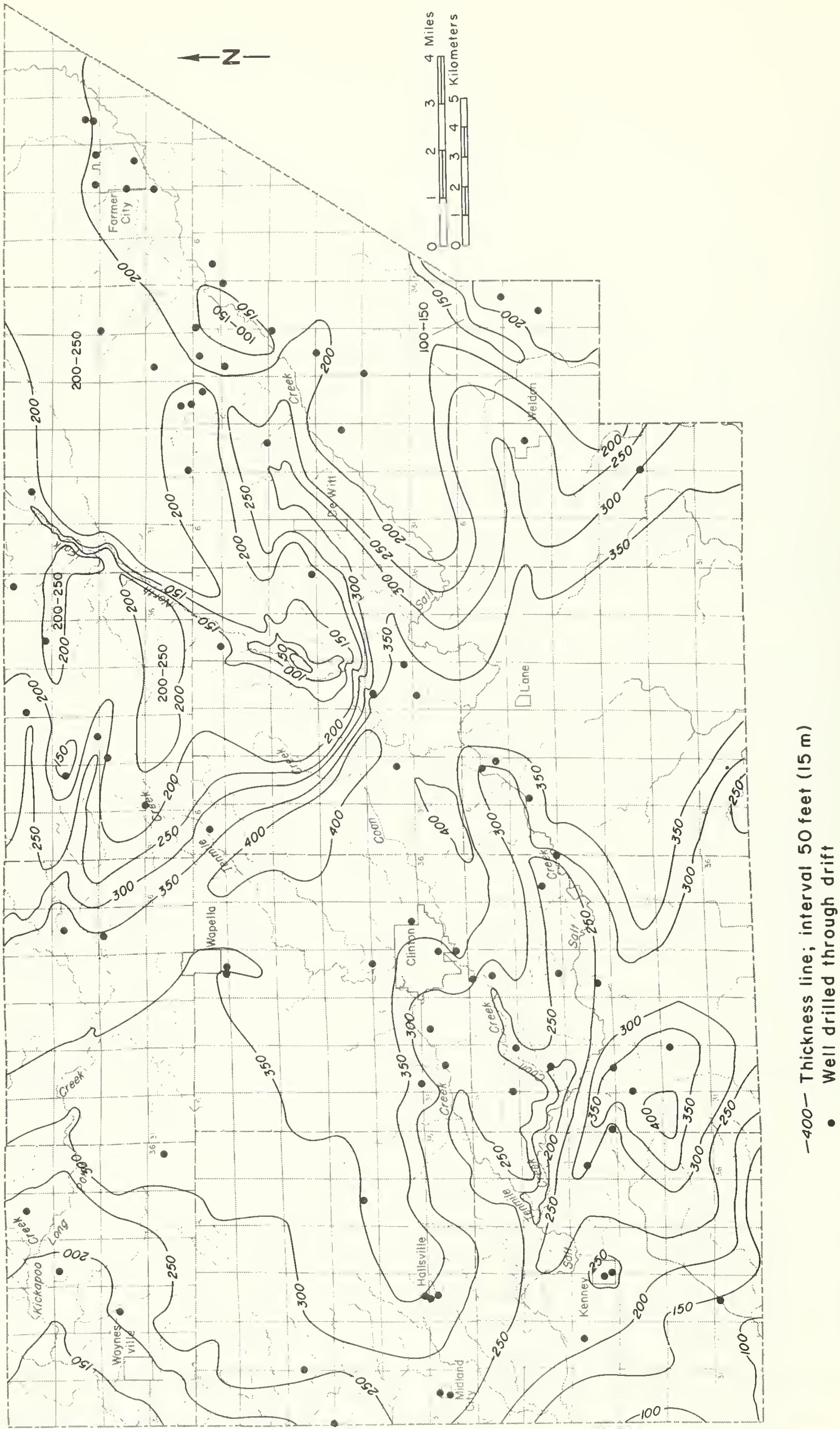
Surficial geology

The unconsolidated surficial deposits that overlie the bedrock range in thickness from slightly more than 50 feet (15 m) to over 400 feet (122 m) (fig. 4) and are the earth materials with the greatest impact on man's activities in De Witt County. Most of these materials are deposits, collectively called *drift*, of the continental glaciers that covered De Witt County during the last million years. The drift is composed mainly of glacial till, which is characterized by a matrix of sand, silt, and clay, with scattered



Topography of bedrock surface, De Witt County, Illinois

Figure 3



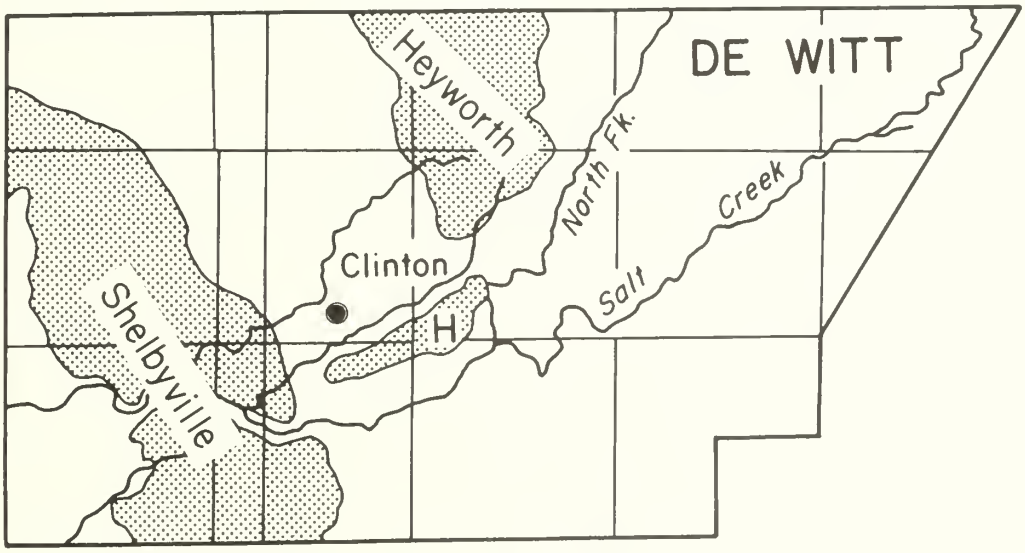
Thickness of glacial drift, De Witt County, Illinois

Figure 4

pebbles, cobbles, and some large boulders. Interbedded with the glacial till is sand and gravel that was released by melting glaciers and carried from the glaciers' margins by streams. Sand and gravel layers are scattered and discontinuous in the shallow drift in the county, but a thick, basal sand and gravel deposit fills the bedrock valleys. Several deposits of peat or old soils, which frequently separate the deposits of individual glacial advances, have been found in De Witt County. Deposits 4 to 12 feet (1.2 to 3.7 m) thick composed of wind-blown silt with small amounts of wind-blown sand cover most of the county. In these deposits, called *loess*, the Modern Soil has developed. The most recent deposits not directly related to glaciation are the floodplain deposits (called *alluvium*) found adjacent to streams in De Witt County.

The surface features of De Witt County were formed during the last two stages of glaciation, the Illinoian and the Wisconsinan. Along the western margin of the county is the Shelbyville Morainic System (fig. 5), which marks the farthest advance of the Wisconsinan (most recent) glaciation. West of this ridge, all the glacial deposits are of Illinoian age and are mantled by Wisconsinan loess. The third and oldest glaciation represented in the county, the Kansan, is buried beneath the deposits of the younger two stages.

The distribution of the geologic materials present from the land surface to a depth of 20 feet (6 m) is shown in figure 6. The deposits of the three main stages of glaciation have been classified as formations consisting, from oldest to youngest, of the Banner Formation (Kansan), the Glasford Formation (Illinoian), and the Wedron Formation (Wisconsinan) (fig. 2). The Banner Formation does not appear on figure 6 because it is found at depths greater than 20 feet (6 m); the Glasford Formation is symbolized *g* and the Wedron Formation, *w*. The Wedron Formation forms the bulk of the surface deposits throughout De Witt County and is generally the thinnest of the three formations. The cross sections shown in figure 7 present the general vertical distribution of these units.



Woodfordian moraines of De Witt County, Illinois

Figure 5

Although nowhere present within 20 feet (6 m) of land surface, the Banner Formation is significant chiefly because it includes the Mahomet Sand Member, a thick outwash sand and gravel deposited during the Kansan Stage. The Mahomet Sand Member, which reaches a maximum thickness of about 150 feet (46 m), fills the channel of the Mahomet Bedrock Valley and a small subsidiary valley that angles northwestward beneath the town of Kenney and into Logan County.

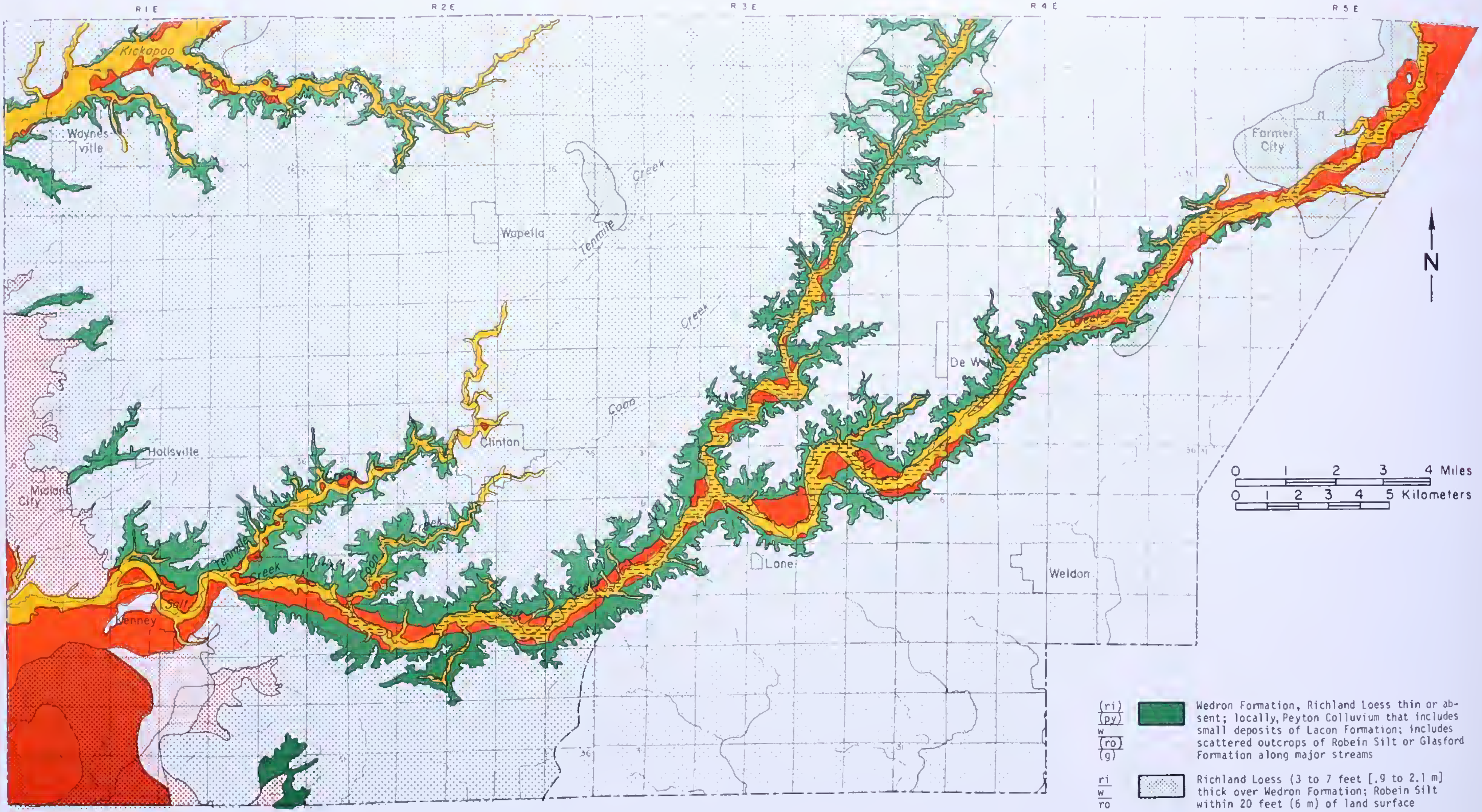
The Glasford Formation, deposited during Illinoian glaciation, consists of several individual till layers that are commonly separated by thin, discontinuous layers of sand and gravel. The uppermost of these layers, the Radnor Till Member (symbolized *gr*), is a compact, gray silty till, which may be found within 20 feet (6 m) of the land surface within the county and is the uppermost till in the southwestern corner of the county. The Radnor Till is most often found in the northern part of the county where the Wedron Formation is less than 20 feet (6 m) thick and along the sides of the valleys cut through the Wedron Formation by Salt Creek and Kickapoo Creek.

An easily recognized marker horizon, the Robein Silt (symbolized *ro*), separates the Glasford Formation from the Wedron Formation. The Robein Silt is an organic sediment, often containing twigs and logs, composed of dark, brown-to-black, highly organic silt. Local well drillers refer to Robein Silt as black dirt or muck. The age of this material ranges from 21,000 to 28,000 radiocarbon years B.P. (before present) in the region. The Robein Silt marks a major period of ice withdrawal during the Wisconsinan Stage of glaciation. Where present, the Robein Silt averages about 2 to 3 feet (.6 to .9 m) thick, although it may reach thicknesses of 5 or 6 feet (1.5 or 1.8 m). Where thin, it probably represents an old wet prairie soil; where thick, it may have accumulated in bogs or depressions. Although other organic deposits are locally encountered within the older sequence of glacial deposits, the Robein Silt is by far the most persistent. These organic units generate methane gas, which is frequently present in water wells in the area (Meents, 1960).

The overlying Wedron Formation, deposited during Wisconsinan glaciation, consists of two till members: the Fairgrange Till Member (*wf*) (Ford, in preparation), which is the surface till throughout the western half of the county, and the Piatt Till Member (*wp*) (Wickham, in preparation), which forms the surface till of the eastern half of the county, as shown in figure 6. The Fairgrange Till, a gray-brown silty till, weathers brown; the Piatt Till, a gray, sandy, silty till, weathers tan to brown. The Fairgrange Till is likely to be found within 20 feet (6 m) of the surface below the upper Piatt Till but may be absent in areas where the Piatt Till rests directly on the Robein Silt or on the Glasford Formation.

The surface sand and gravel deposits of Wisconsinan age are glacial outwash deposits belonging to the Henry Formation (*h*), which consists of two members in De Witt County. The Mackinaw Member (*hm*) consists of fairly well sorted, medium sands to gravels found in terraces along Salt Creek and Kickapoo Creek and beneath the modern alluvium in those creek valleys. The Batavia Member (*hb*) forms a gently sloping plain of fine sand to medium gravel deposited by glacial meltwater at the margin of the Wedron Formation in southwestern De Witt County. This type of deposit, often called an *outwash plain*, is usually found on the foreslope of an end moraine.

Loess covers almost the entire surface of De Witt County. Where it overlies the Glasford Formation in the southwestern corner, it is called the *Peoria*



c/hm c/hm/(g)	🟨	Cahokia Alluvium (5 to 15 feet [1.5 to 4.5 m] thick) generally underlain by the Henry Formation (Mackinaw Member) in the Salt and Kickapoo Creek valleys and by the Wedron Formation in the upstream portions of the tributary valleys. Stipple pattern indicates where the Glasford Formation may be within 20 feet (6 m) of the land surface.
ri/hm	🟥	Richland Loess (3 to 5 feet [.9 to 1.5 m] thick) over Henry Formation (Mackinaw Member)
ri/wp/(wf)	☐	Richland Loess (3 to 5 feet [.9 to 1.5 m] thick) over Wedron Formation (Piatt Till Member). Locally the Fairgrange Till Member may occur within 20 feet (6 m) of the land surface.
ri/wf	▨	Richland Loess (4 to 7 feet [1.2 to 2.1 m] thick) over Wedron Formation (Fairgrange Till Member)
(ri)/(py)/w/(ro)/(g)	🟩	Wedron Formation, Richland Loess thin or absent; locally, Peyton Colluvium that includes small deposits of Lacon Formation; includes scattered outcrops of Robein Silt or Glasford Formation along major streams
ri/w/ro	▨	Richland Loess (3 to 7 feet [.9 to 2.1 m] thick over Wedron Formation; Robein Silt within 20 feet (6 m) of land surface
ri/hb/wf/(ro)	▨	Richland Loess (4 to 7 feet [1.2 to 2.1 m] thick) over Henry Formation (Batavia Member) over Wedron Formation (Fairgrange Till Member); Robein Silt may be within 20 feet (6 m) of the land surface locally
ri/hb	▨	Richland Loess (greater than 7 feet [2.1 m] thick) over Henry Formation (Batavia Member)
p/(hb)/(ro)/(r)/gr	🟥	Peoria Loess (greater than 7 feet [2.1 m] thick) over thin, discontinuous Henry Formation (Batavia Member) over Robein Silt or Roxana Silt over Glasford Formation (Radnor Till Member)
p/(ro)/(r)/gr	🟥	Peoria Loess (greater than 7 feet [2.1 m] thick) over Robein Silt or Roxana Silt over Glasford Formation (Radnor Till Member)
sm	☐	Gravel pit

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Geologic materials to a depth of 20 feet (6 m), De Witt County, Illinois

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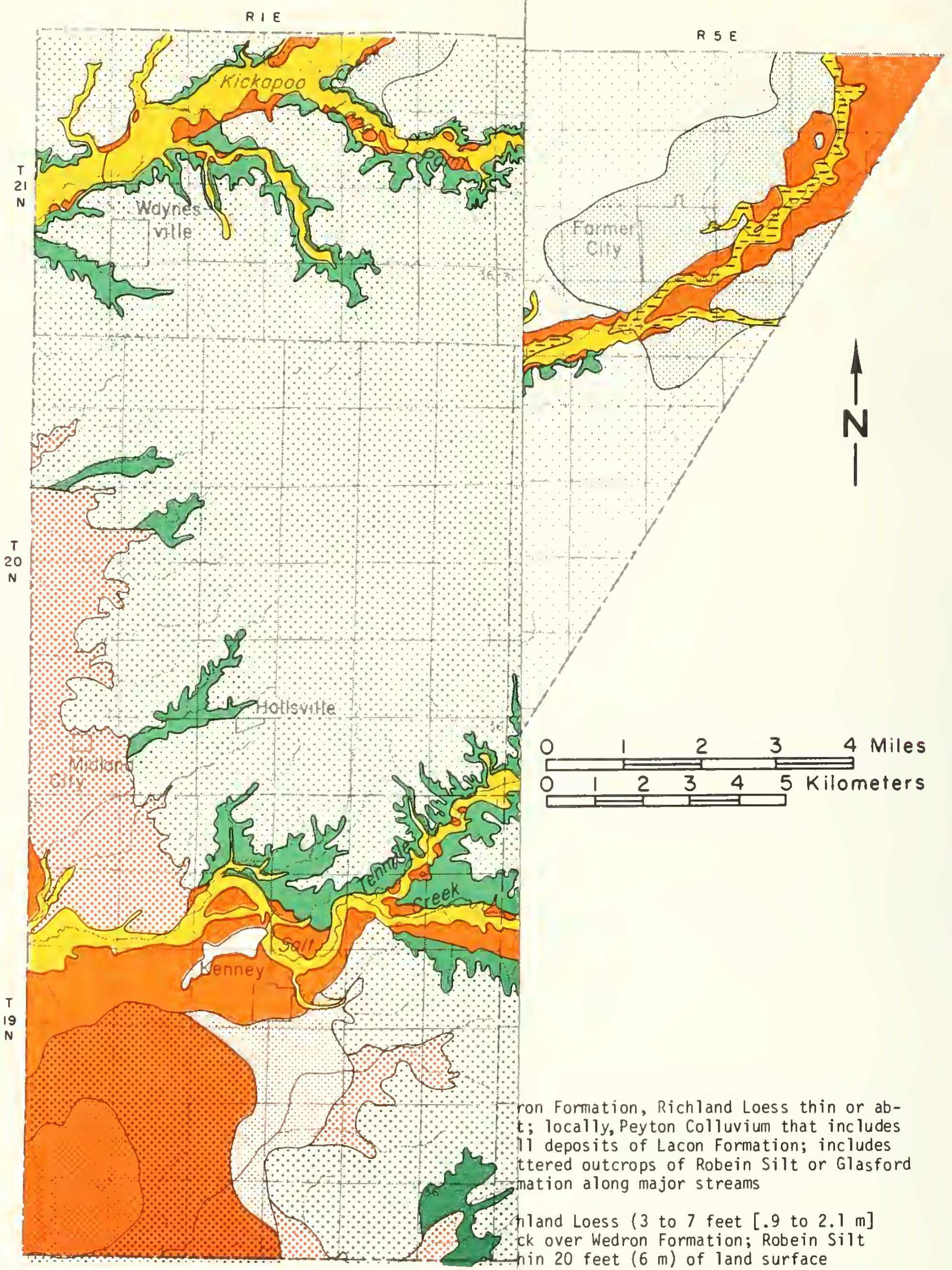

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Figure 6

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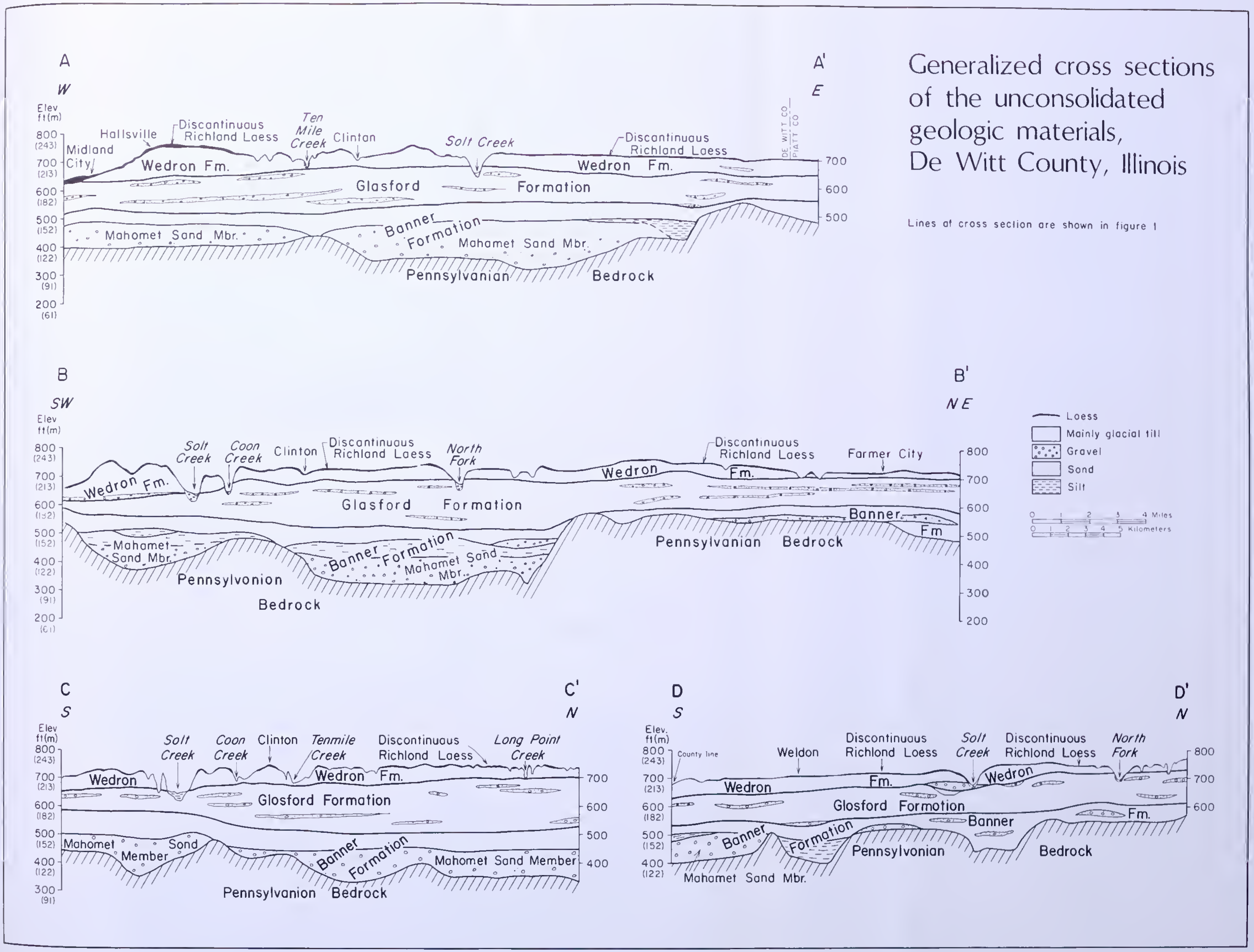


Generalized cross sections of the unconsolidated geologic materials, De Witt County, Illinois

Lines of cross section are shown in figure 1

Figure 7

Loess (symbolized *p*). In that area, the Peoria Loess, which is yellowish tan, may locally overlie a thin deposit of Robein Silt and an older loess, the Roxana Silt (symbolized *r*), which is characteristically brown. The Roxana Silt was deposited during an older Wisconsinan glaciation that did not reach this region. The combined thickness of the Peoria Loess and the Robein and Roxana Silts in the southwestern corner of the county may be as much as 15 feet (4.6 m). The average thickness of the Peoria Loess probably exceeds 7 feet (2.1 m). The silt covering the Wedron Formation tills or the Henry Formation is called the *Richland Loess* (*ri*). The Richland Loess is tan to yellowish tan and generally ranges from 4 to 7 feet (1.2 to 2.1 m) thick where it overlies the Fairgrange Till Member in the west. Where it overlies the Piatt Till Member of the Wedron Formation in eastern De Witt County, the Richland Loess generally ranges from 3 to 5 feet (.9 to 1.5 m) thick. The Morton Loess is not present at the land surface in De Witt County; however, it appears locally in the subsurface as a thin, grayish silt layer between the Robein Silt and the Wedron Formation.

The youngest deposits mapped in the county have been named the *Cahokia Alluvium* (*c*). These alluvial deposits range in thickness from 5 to 20 feet (1.5 to 6 m) along the major valleys and are generally no more than 2 or 3 feet (.6 or .9 m) thick along smaller tributary valleys. The Cahokia Alluvium is considered to be Holocene (recent). The deposits usually consist of silts and sands with some organic material and may include reworked sand and gravel of the Henry Formation or the products of erosion and slope wash from the till and loess deposits on uplands.

An additional mapped deposit shown in figure 6 occurs in areas of highly dissected slopes, mainly along the major valleys in the county, where the Richland Loess has been removed by erosion and the Wedron Formation is exposed at the surface. At the base of the slopes, the Robein Silt and the Radnor Till Member of the Glasford Formation may be exposed. Along these slopes are areas where material has moved or been moved down the surface and collected toward the base, forming deposits of colluvium with localized zones of mass wasting (e.g., landslide debris, slumped material, or mud flows), which are of late Wisconsinan and Holocene age. The composition of these deposits depends on the material composition of the slope from which they are derived. The colluvium is called the *Peyton Colluvium* (symbolized *py*) and the material deposited as a result of mass wasting is called the *Lacon Formation*. Mass wasting and colluvial deposits indicate areas of uncertain slope stability that may affect construction conditions.

resources

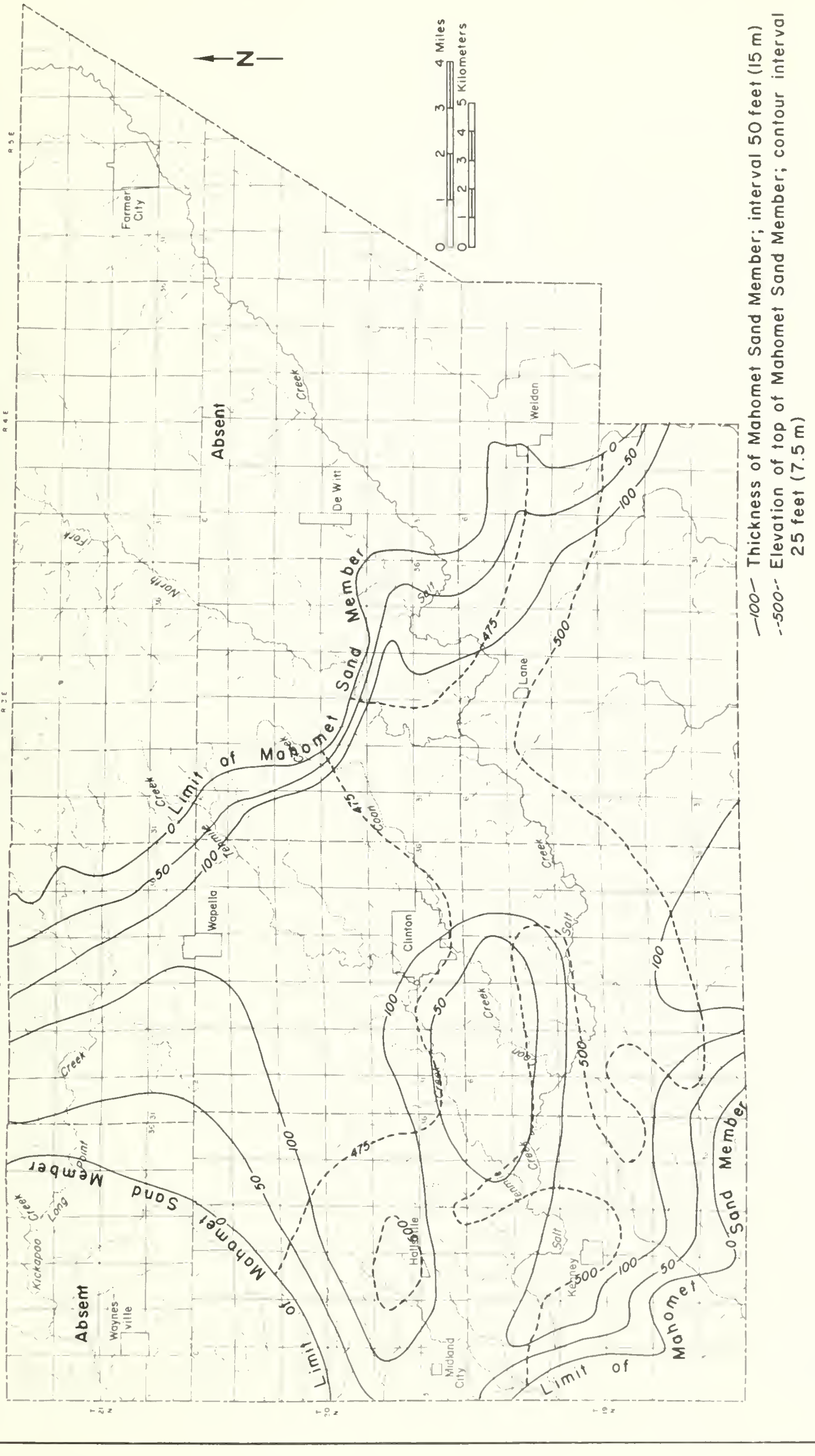
Ground water

The bedrock in De Witt County is not a favorable source of ground water because the shallow Pennsylvanian-age rock is composed of tight shales with thin, interbedded limestones, sandstones, and coal and the deeper aquifers, the sandstones and limestones in particular, contain water too highly mineralized for use. A few wells yield small quantities of water from the upper few tens of feet of the Pennsylvanian bedrock from fractures in the shale and limestone or from sandstones that are locally present; however, the Pennsylvanian rocks are usually considered for a source of water only when adequate supplies cannot be obtained from the drift.

The possibility of developing small supplies of ground water for farm and domestic use from wells finished in the drift of De Witt County is generally good. The potential for development of moderate-to-large ground-water supplies from the drift ranges from poor, as in the southwestern and northeastern corners of the county, to extremely favorable in the center, where the Mahomet Sand Member is present. Figure 7 illustrates the vertical sequence of deposits in De Witt County, including the thick Mahomet Sand Member in the Mahomet Bedrock Valley, and the discontinuity of the interbedded sand and gravel deposits within and between the Glasford Formation and the upper half of the Banner Formation. Where the Mahomet Sand Member reaches its maximum thickness east of Clinton (fig. 8), the uppermost zone contains 50 to 75 feet (15 to 23 m) of silty sand with some gravel. This zone is neither as permeable nor as productive as the zone beneath, which generally contains sand and fine-to-medium gravel. The Mahomet Sand Member is less favorable as an aquifer where the bedrock surface is at elevations of 450 feet (137 m) or higher (fig. 8) or where only the upper, finer portion of the sand is present. Figure 9 shows the depth to the top of the Mahomet Sand Member.

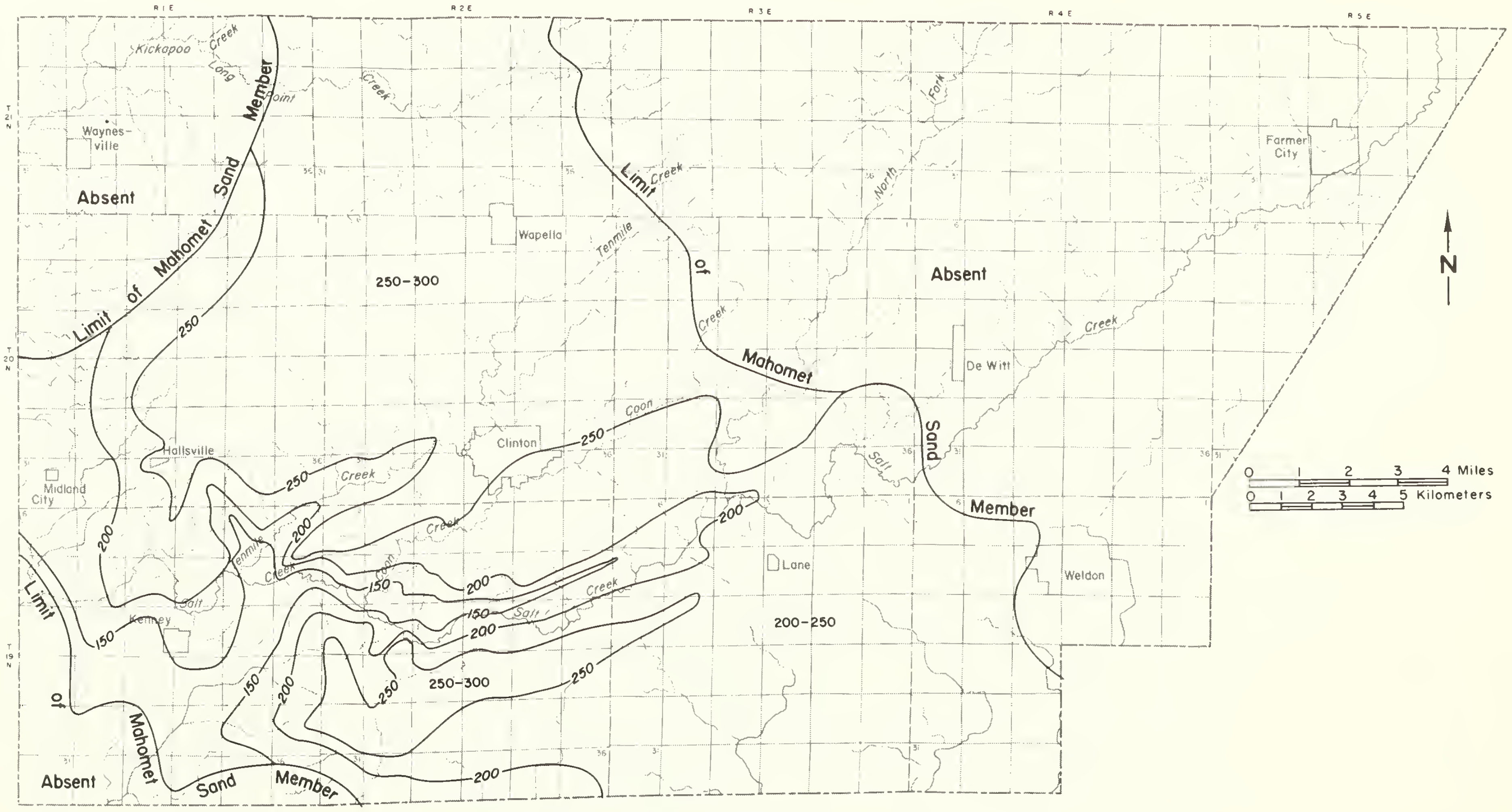
The area outlined by the principal channel of the Mahomet Bedrock Valley is the region of the county that has the greatest potential for the development of large ground-water supplies. Production rates of 500 gallons per minute (1900 liters per minute) are reported from a well at Clinton and from a well east of Clinton recently drilled for Illinois Power Company. Since both wells are at the margins of the thicker and more permeable portions of the Mahomet Sand Member, wells drilled in the middle of the valley, in the southern half of T. 19 N., R. 3 E., for example, might yield substantially higher quantities of water.

Sand and gravel deposits found in the Cahokia Alluvium or in the Henry Formation of creek valleys may yield small-to-moderate ground-water supplies. Wells finished in these deposits must be constructed in a manner that prevents pollution of the ground water by surface water during periods of high water or flood.



Thickness and elevation of the top of the Mahomet Sand Member, De Witt County, Illinois

Figure 8



—200— Depth to top of Mahomet Sand Member; interval 50 feet (15 m)

Depth to the top of the Mahomet Sand Member, De Witt County, Illinois

Figure 9

In that part of the county outside of the area where the Mahomet Sand Member is present, most domestic, municipal, and industrial wells are finished in thin, discontinuous beds of sand and gravel within the Banner, Glasford, and Wedron Formations and within the alluvium. Small ground-water supplies are available throughout the county from shallow sand and gravel deposits in the drift and alluvium. Where the Mahomet Sand Member is absent, the potential for developing farm, domestic, and small municipal supplies from the interbedded sands and gravels within the drift and alluvium is good. In these areas, however, test drilling is usually necessary to locate a source of ground water for a supply larger than that needed by the average farm. Data on the extent of the shallow aquifers are insufficient for predicting where and at what depth the aquifers will be encountered in the drift.

Surface water

Small farm ponds or lakes often supplement supplies of water where ground-water sources are inadequate. In De Witt County, the largest reservoir, Weldon Springs Lake, covers 28 acres (11 ha) about 5 miles (8 km) southeast of Clinton. The dam proposed by Illinois Power Company will provide the region with a large lake for recreation, flood control, and water storage.

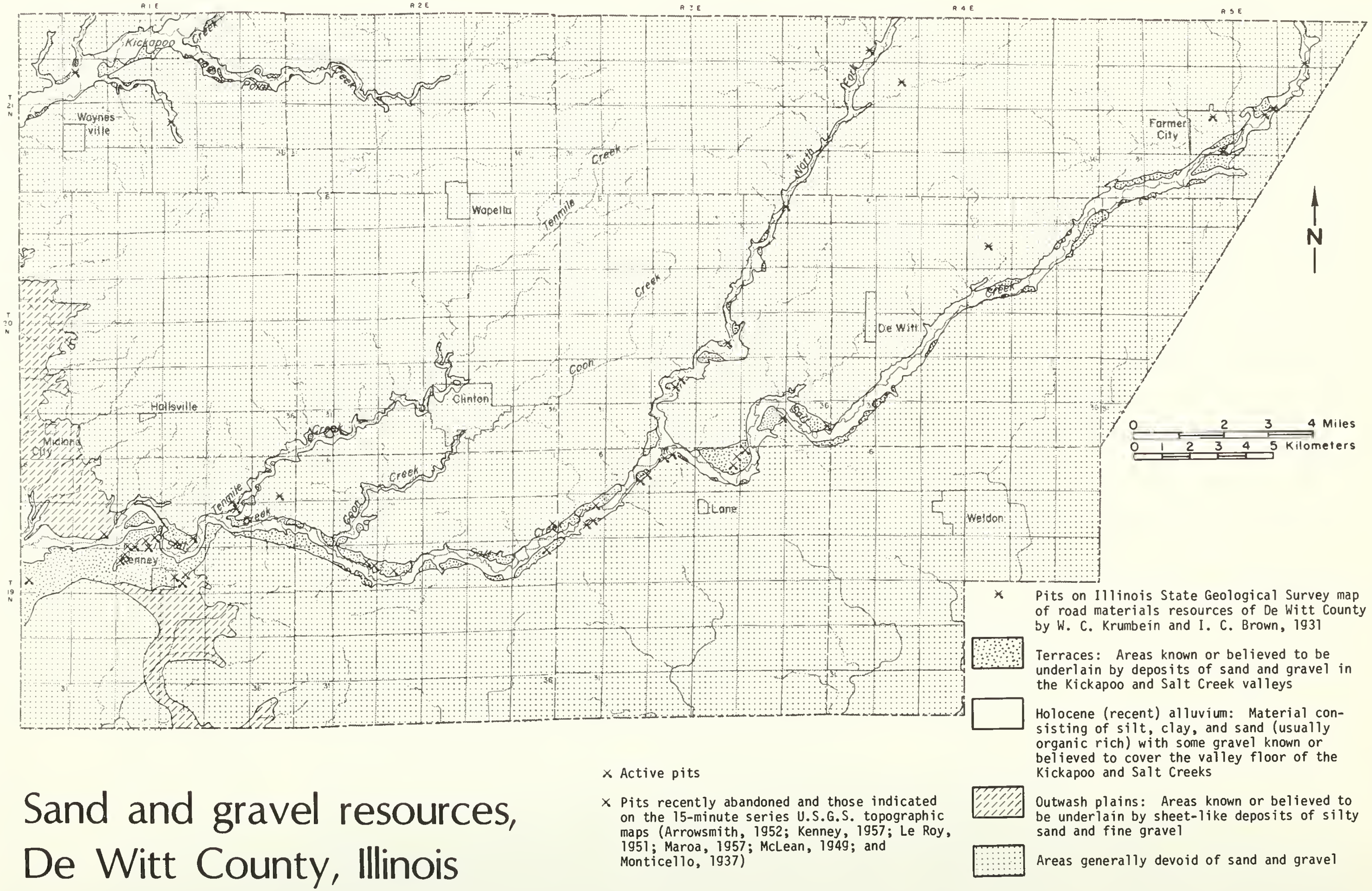
Many valleys in the watersheds of Salt Creek and Kickapoo Creek are too shallow for reservoir development, and none of the tributaries to Friends Creek within De Witt County is suitable for reservoir development. Potential reservoir sites have been found along Salt Creek, North Fork, Coon Creek, and Tenmile Creek in the Salt Creek watershed and along Long Point Creek and Rock Creek in the Kickapoo Creek watershed (Dawes and Terstriep, 1966). If reservoirs were developed on all the suitable streams in De Witt County, the storage of surface water would be about 24,800 million gallons (94,240 million liters) contained in a pool area of 4492 acres (1818 ha).

Sand and gravel

De Witt County produced less than 99,000 tons of sand and gravel in 1974 (Malhotra and Hallaron, 1977, fig. 8). The small size of the operating pits reflects not only the small quantities of near-surface reserves, but also the low demand for aggregates in De Witt County as compared to more populous counties. Two operators in De Witt County produce sand and gravel from four pits approved for use as class D quality base and surface aggregate (Illinois Department of Transportation, 1973). One of these is approved for class A and class B quality fine aggregate. With additional beneficiation to remove deleterious particles, the large pits near Kenney (fig. 10) might also produce higher grades of certain coarse sizes suitable for use as concrete and bituminous aggregate.

The following discussion and the legend of figure 10 present the various types of sand and gravel deposits in the order of their importance as resources, which depends on the thickness of overburden, thickness and extent of the deposit, grain size distribution and rock types present in the deposit, accessibility of the deposit, and distance from the point of use. Boundaries of the deposits on figure 10 are the same as those on the map of surficial geology (fig. 6).

Terrace deposits. Terrace deposits (the Mackinaw Member of the Henry Formation) are and will continue to be the most important sources of sand and gravel, and


R 1 E
R 2 E
R 3 E
R 4 E
R 5 E
T 21 N
T 20 N
T 19 N
N
Kickapoo Creek
Fork
Creek
Waynesville
Wapella
Tenmile Creek
North Fork
Farmer City
Creek
Coon Creek
De Witt
Clinton
Hallsville
Midland City
Creek
Tenmile Creek
Coon Creek
Salt Creek
Lane
Weldon
Kenney
0 2 3 4 Miles
0 1 2 3 4 5 Kilometers
× Pits on Illinois State Geological Survey map of road materials resources of De Witt County by W. C. Krumbein and I. C. Brown, 1931
Terraces: Areas known or believed to be underlain by deposits of sand and gravel in the Kickapoo and Salt Creek valleys
Holocene (recent) alluvium: Material consisting of silt, clay, and sand (usually organic rich) with some gravel known or believed to cover the valley floor of the Kickapoo and Salt Creeks
Outwash plains: Areas known or believed to be underlain by sheet-like deposits of silty sand and fine gravel
Areas generally devoid of sand and gravel
× Active pits
× Pits recently abandoned and those indicated on the 15-minute series U.S.G.S. topographic maps (Arrowsmith, 1952; Kenney, 1957; Le Roy, 1951; Maroa, 1957; McLean, 1949; and Monticello, 1937)

Sand and gravel resources, De Witt County, Illinois

Figure 10

all sand and gravel currently produced in De Witt County comes from terrace deposits. The largest sand and gravel operations in the county are west of the margin of the Shelbyville Morainic System just north of Kenney (fig. 10), where the terrace deposits are most extensive. Terrace deposits along Salt Creek become generally thinner and siltier upstream from the western edge of the Shelbyville Moraines. The possibility of finding commercial sand and gravel seems to decrease as the valley sides diminish in height and slope upstream to the northeast and gradually merge with the general land surface northeast of Farmer City (fig. 10). In the downstream portion of the valley, terraces may contain as much as 20 to 30 feet (6 to 9 m) of sand and gravel below 5 to 10 feet (1.5 to 3 m) of overburden. The gravel content of samples from these terraces is 15 to 30 percent, with 1 to 10 percent of the samples being coarser than 1 inch (2.5 cm) in diameter.

Several of the most favorable terraces in Salt Creek have already been exploited. Current activity is limited to the large terrace one mile northeast of Lane, on the north side of the creek, and to a much smaller terrace south of Weldon Springs Park on the south side of the creek. Although no pits operate along the North Fork of Salt Creek at present, North Fork is the only tributary to Salt Creek where pits might be expected to produce more than just fill material for local use. In general, the Salt Creek valley is narrow, and the terraces are limited in area and variable in their sand and gravel content. Their development as a resource is most favorable when a road suitable for haulage passes nearby.

Terraces in the small portion of the main Kickapoo Creek valley within De Witt County are potential sources of sand and gravel, since samples from a nearby pit in these terraces usually contain 30 to 50 percent gravel. Above the water table 5 to 25 percent of the deposit consists of gravel coarser than 2 inches (5 cm) in diameter, whereas below the water table 1 to 10 percent of the deposit consists of gravel coarser than 2 inches (5 cm) in diameter. Gravel deposits in tributary valleys to Kickapoo Creek in De Witt County are probably too thin to produce more than local fill material.

Floodplain deposits. Ranking second as possible resource areas are the floodplain portions of the main valleys of Kickapoo and Salt Creeks that contain recent (Cahokia) alluvium underlain by valley train sand and gravel (Mackinaw Member of the Henry Formation). The alluvium may range from 5 to 20 feet (1.5 to 6 m) thick, but where it is thin, it may overlie up to 20 feet (6 m) of sand and gravel. Commercial development is most likely to occur in the following areas: (1) the main Kickapoo valley where producible sand and gravel underlies the alluvium and (2) the main Salt Creek valley about as far upstream as the Route 10 bridge crossing. If some portions of the alluvium are low in silt and clay, the alluvium may be suitable as a resource, but more important deposits will be those where outwash sand and gravel is preserved at shallow depths under the alluvium.

Outwash plain deposits. Ranking third as possible sources are deposits that form a thin outwash plain (Batavia Member of the Henry Formation) along the western edge of the Shelbyville Moraines. These deposits probably pinch out a mile or so to the west of the moraines. The outwash plain extends to the southeast in Macon County, where it has been described by Hester and Anderson (1969) on the basis of data from exploratory power auger holes. In general, they found 5 to 15 feet (1.5 to 4.6 m) of silt and clay overlying less than 5 feet (1.5 m) of sand with some gravel. This description probably also applies to most of the outwash plain in De Witt County. The most likely source of commercial sand and gravel is the area south and possibly north of the portion of outwash plain bisected by alluvial and terrace deposits of Salt Creek. Channel deposits of outwash sand and gravel may be present in this area buried under the gently westward sloping surface topography of the outwash plain.

Coal

In Illinois, coal is contained in the Pennsylvanian System, which is the uppermost bedrock in De Witt County. The Pennsylvanian strata are about 400 to 800 feet (122 to 244 m) thick in De Witt County and contain at least seven named coal members (Clegg, 1972), whose stratigraphic positions are shown in figure 11. Of the seven recognized coals, the Springfield (No. 5) Coal Member, which lies at depths of 450 to 500 feet (137 to 152 m), has the greatest average thickness—about 4 feet (1.2 m). Although coal 3 to 3.5 feet (.9 to 1.0 m) thick was once mined underground in Illinois, in recent years coal averaging about 4.5 feet (1.4 m) thick has been the minimum thickness mined; the average thickness of coal mined underground in Illinois is about 6 feet (1.8 m).

Smith and Stall (1975) reported 1,464,182,000 tons (1,328,297,000 metric tons) of resources for the Springfield Coal greater than 42 inches (114 cm) thick in De Witt County. These reserves represent an estimate based on available data of the total amount of coal in the ground. No exclusions were made for mining conditions, populated areas, or manmade structures that might restrict mining. The figure for total coal in the ground does not indicate the amount of coal that may be recovered, which depends on many characteristics of the coal deposits, including thickness, minability, and availability for mining, and on a wide range of economic conditions. Neither surface nor underground coal mining has taken place in De Witt County. Because of the absence of thick coal beds near the bedrock surface and the thickness of overlying drift (fig. 4), there is no known potential for surface mining in De Witt County.

Since no test holes for coal have been drilled in De Witt County, most of the data on coal thickness have been interpreted from electric logs from oil test holes. Because these data represent only an estimate of coal thickness, the resources of the Springfield Coal in De Witt County are classed as "inferred" and should be substantiated by test drilling. The Springfield Coal Member has been mined in Logan County and fairly extensively in the vicinity of Springfield, Sangamon County, where the coal averages from 5.5 to 6 feet (1.6 to 1.8 m) thick. The quality of Springfield Coal in De Witt County is probably similar to the quality of the coal in Sangamon County (Clegg, 1961).

Oil and gas

The known petroleum resources of De Witt County are confined to the Wapella East Field and the Parnell Field (fig. 12) (Howard, 1964). Oil is produced from the Mississippian-age Sonora Sandstone and Devonian-age limestone at the Parnell Field and from Silurian-age dolomite at the Wapella East Field. Oil production statistics for the two pools are shown in table 1.

Gas is often found in the organic-rich silt zones present in the glacial drift. These zones are sometimes encountered while drilling for water. In De Witt County, some drift-gas wells supply sufficient gas for homes. It is difficult to predict the location of deposits of organic-rich silts that will yield

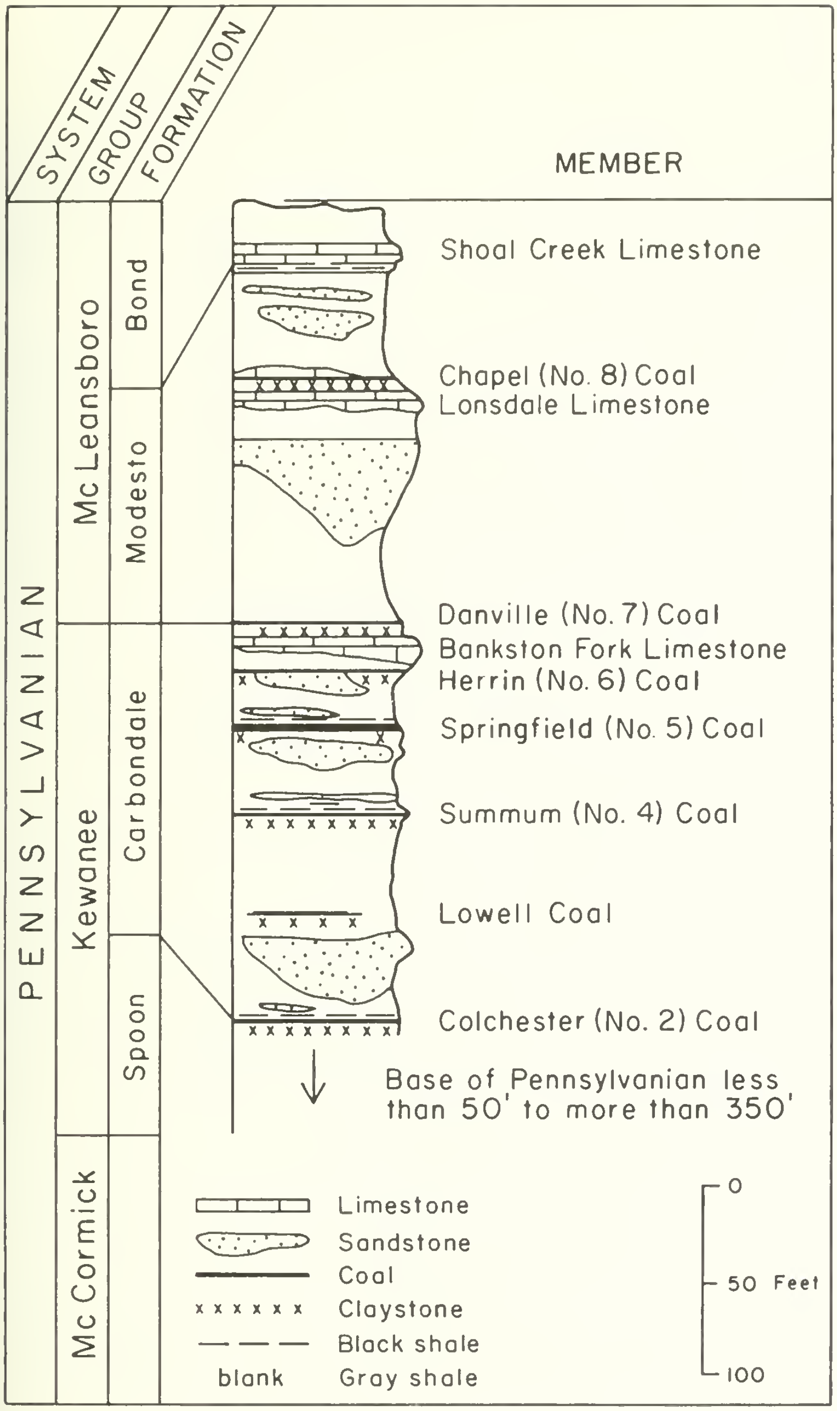


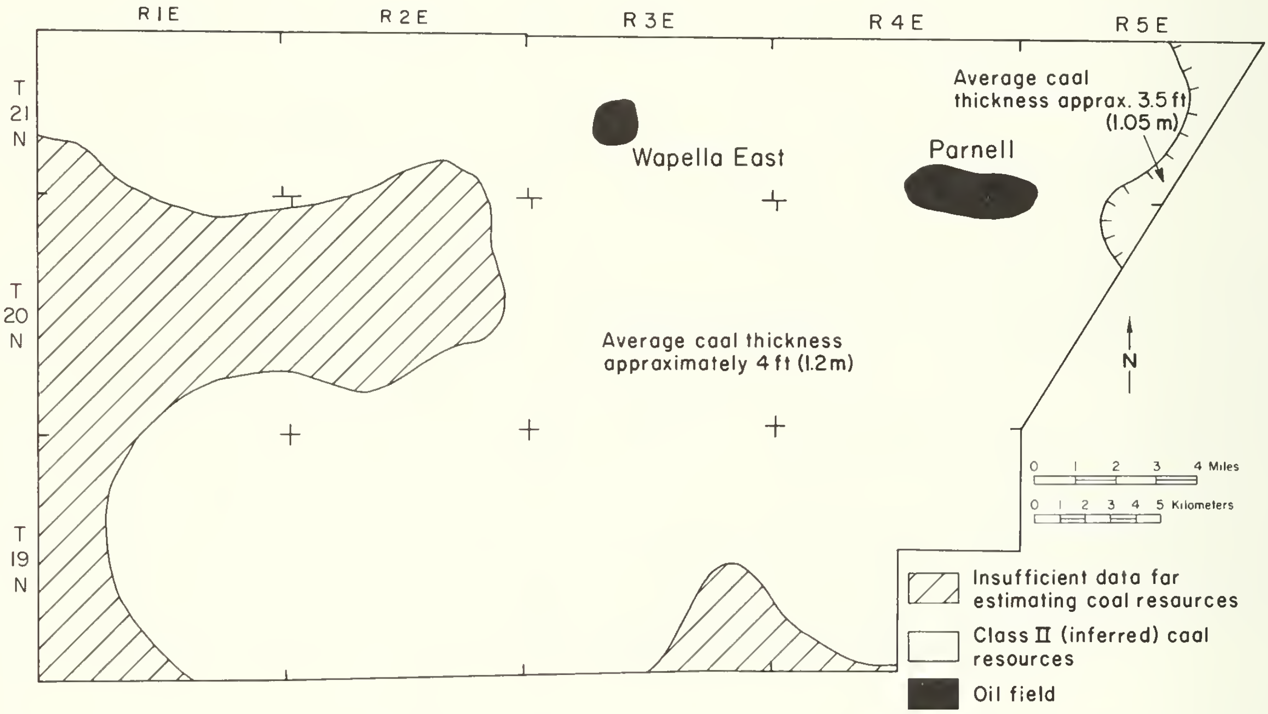
Figure 11. Generalized stratigraphic section of the uppermost Pennsylvanian strata, De Witt County, Illinois.

gas; however, most of the producing drift-gas wells are found in the western part of the county along the Shelbyville Morainic System (Meents, 1960). The source of the gas in these wells is probably the organic-rich zone (Robein Silt) between the Glasford and Wedron Formations.

Soils

Twenty-three soil types have been mapped in De Witt County (Smith and Smith, 1940). On the upland, the most common soil types are the Flanagan silt loam, the Drummer clay loam, and the Harpster clay loam. These three soil types cover approximately 60 percent of the county. The other 20 soil types are found along the slopes and in the valleys of the streams and their tributaries as well as on and west of the Shelbyville Morainic System in the western and southwestern portions of the county. The upland soils are used in agricultural crop production, and the soils along the slopes and in the valleys of the creeks are used for timber or pasture. The soils on and west of the Shelbyville Moraines are used for crop production, timber, or pasture, depending on local conditions.

About one-third of the soil cover of De Witt County is poorly drained; that is, water is retained at or near land surface for long periods of time, and during


R1E
R2E
R3E
R4E
R5E
T 21 N
T 20 N
T 19 N
Wapella East
Parnell
Average coal thickness approx. 3.5 ft (1.05 m)
Average coal thickness approximately 4 ft (1.2m)
N
0 1 2 3 4 Miles
0 1 2 3 4 5 Kilometers
Insufficient data for estimating coal resources
Class II (inferred) coal resources
Oil field

Oil fields and thickness of the Springfield (No. 5) Coal Member in De Witt County, Illinois

Figure 12

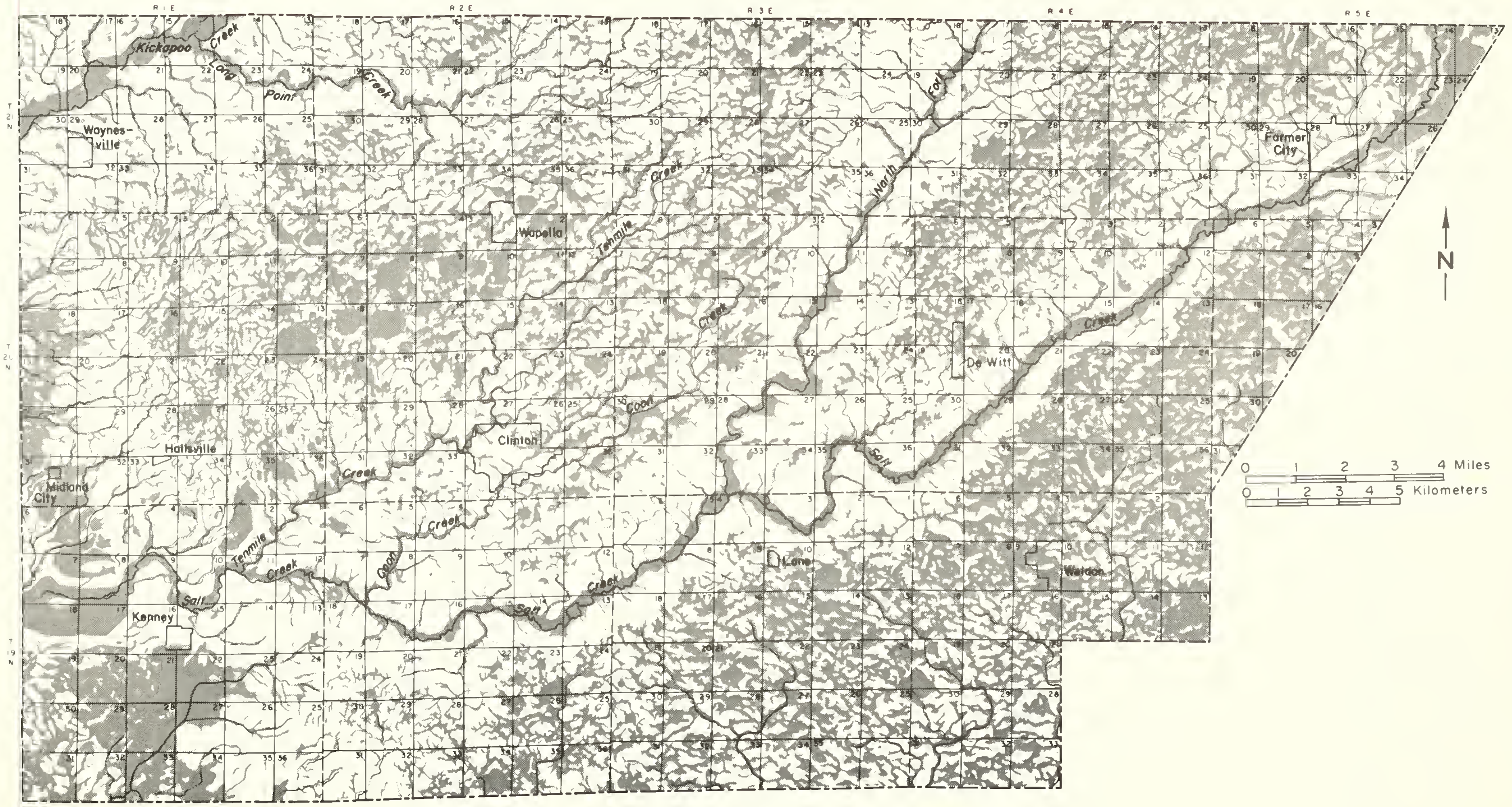
TABLE 1

De Witt County oil production statistics

POOL	LOCATION	PAY ZONE Name	PAY ZONE Depth (ft)	YEAR OF DISCOVERY	AREA PROVED (acres)	NUMBER OF WELLS Completed to end of 1974	NUMBER OF WELLS Production at end of 1974	OIL PRODUCTION (bbl) During 1974	OIL PRODUCTION (bbl) Through 1974
Parnell	T. 20-21 N.,			1963	610	39	38		
	R. 4-5 E.	Sonora Ss.	670	1963	590	36	35	27,000	154,300
		Devonian ls.	1100	1964	20	3	3		
Wapella East	T. 21 N., R. 3 E.	Silurian dol.	1112	1962	350	36	36	128,800	2,492,000

Source: Van Den Berg and Lawry, 1975, table 8.

periods of especially high rainfall or flood, ponding may occur. The poorly drained soil types have been grouped together to develop a map (fig. 13) of poorly drained areas. Poorly drained soil conditions should be taken into consideration in construction as well as in agricultural pursuits. The local and regional offices of the USDA Soil Conservation Service and the *De Witt County Soils Report* (Smith and Smith, 1940) are valuable sources of information on local soil conditions in De Witt County.



Poorly drained soils, De Witt County, Illinois

Figure 13

land uses

Geologic conditions for solid-waste disposal

Both the location of a site for solid-waste disposal and the operational procedures to be employed must be approved by the Illinois Environmental Protection Agency. Although disposal of solid wastes may be accomplished by contained high-temperature incineration, sanitary landfill, or composting, the sanitary landfill is the most frequently applied method.

The primary consideration of the siting of a sanitary landfill is whether ground or surface water will be polluted by the operation. According to regulations established by the Illinois Environmental Protection Agency (Cavanagh, 1973) the following guidelines should be observed in locating a site for a sanitary landfill:

1. No disposal should take place in standing water.
2. No disposal should take place in an area having a high ground-water table unless preventive measures are taken to safeguard the ground water.
3. No surface runoff should flow into or through the operating or completed fill area.
4. No disposal should take place unless subsoil material affords reasonable assurance that leachate from the landfill will not contaminate ground or surface water.

Necessary information for evaluation of a landfill site includes the type and thickness of unconsolidated material at the site, the type of bedrock present, current and potential sources of water, and the topography of the site (Cartwright and Sherman, 1969, p. 7-13). In De Witt County, the type of bedrock is generally not an important factor since the bedrock does not occur at depths less than 50 feet (15 m) from land surface anywhere in the county. In general, at least 30 feet (9 m) of relatively impermeable material must be present between the base of a sanitary landfill and the top of any existing or potential ground-water source. In De Witt County, only the upland areas covered by clayey glacial till meet this requirement consistently.

Figure 14 illustrates the evaluation of the suitability of land in De Witt County for use in solid-waste disposal. The upland area covered by a blanket of loess over glacial till is designated area 1. Land in that area is generally suitable for landfill operations.

Area 2a includes places near sand and gravel resources or where organic silt zones may be within 20 feet (6 m) of land surface. The sand and gravel deposits or the silt zones may yield water to the disposal trenches. The land included in area 2a may be suitable for landfill operations, but it is possible that preventive measures would have to be taken in construction to insure that ground water and surface water would not be polluted. Area 2b includes sloping landscapes where till may be at or near the land surface and where streams or sand and gravel deposits associated with streams may be nearby. A few suitable sites for landfill construction may be available in area 2b; however, special construction and operation procedures would probably be necessary to prevent pollution, especially of surface water.

Areas where loess overlies shallow beds of sand and gravel are included in area 3a. These shallow sands and gravels may be a local source of water and must be protected from contamination. Land in area 3a is generally unsuitable for landfill operations without significant site modifications. Area 3b includes land in the stream valleys where shallow sand and gravel has been deposited by flowing streams. Landfills in this area pose the hazard of contamination of ground water and surface water.

Some locations that are naturally unfavorable can be improved through proper design and engineering. Such practices as laying out diversion ditches, tiling, diking, installing clay liners, and collecting and treating leachate have been employed where natural safeguards are poor. The construction of these artificial safeguards can be expensive and is rarely employed in regions where more suitable landfill sites are available.

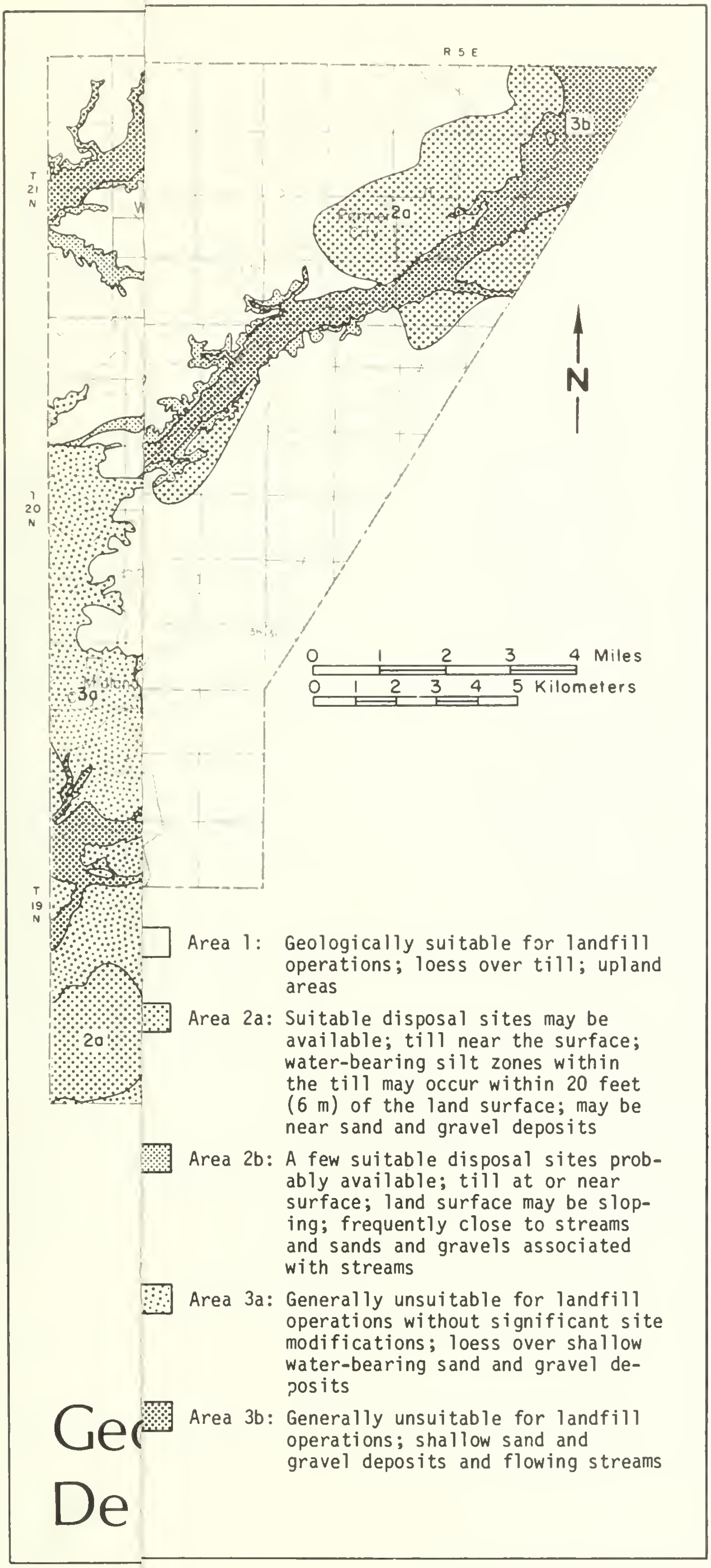
Geologic conditions for construction

Engineering properties of surficial materials. Construction conditions, as determined from the engineering properties of the surficial materials in De Witt County, are generally good. High water tables and poor drainage in surface deposits of wind-blown silt (loess) are the major causes of unfavorable construction conditions in the county. Poor surface drainage causes problems in some places in the county (fig. 13); however, the ease of draining these areas and the accessibility of stable materials within a few feet of land surface make the drainage problem surmountable.

The geologic units mapped in figure 6 have been grouped into units including areas of similar construction conditions and engineering properties (table 2 and appendixes). The sequences of materials in the engineering units mapped in figure 15b are shown in figure 15a.

Conditions least favorable for construction are in the valleys of the major drainageways in the county—Salt Creek, Kickapoo Creek, and Long Point Creek. These areas are coded *Asm/Asg/Gmc(t)/Gsm(t)* in figure 15. (See table 2 and appendix 1.) Alluvial materials deposited by these streams range from silt loam to sand and gravel. (See appendix 2 for classification of materials.) Low bearing capacities (low strengths), high water table, poor drainage, and seasonal flooding make floodplain deposits generally unsuitable areas for construction (table 2).

Beds of sand and gravel were deposited along the stream valleys by water from melting glaciers. Differing textures and drainage conditions in the glacial outwash result in highly variable construction conditions. Water tables are generally high in this material, and flood waters occasionally cover these deposits (coded *Wm/Asg/Gmc(t)* in figure 15). Several feet of loess may cover the outwash



☐ Area 1: Geologically suitable for landfill operations; loess over till; upland areas

▒ Area 2a: Suitable disposal sites may be available; till near the surface; water-bearing silt zones within the till may occur within 20 feet (6 m) of the land surface; may be near sand and gravel deposits

▓ Area 2b: A few suitable disposal sites probably available; till at or near surface; land surface may be sloping; frequently close to streams and sands and gravels associated with streams

░ Area 3a: Generally unsuitable for landfill operations without significant site modifications; loess over shallow water-bearing sand and gravel deposits

▓ Area 3b: Generally unsuitable for landfill operations; shallow sand and gravel deposits and flowing streams

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Figure 14

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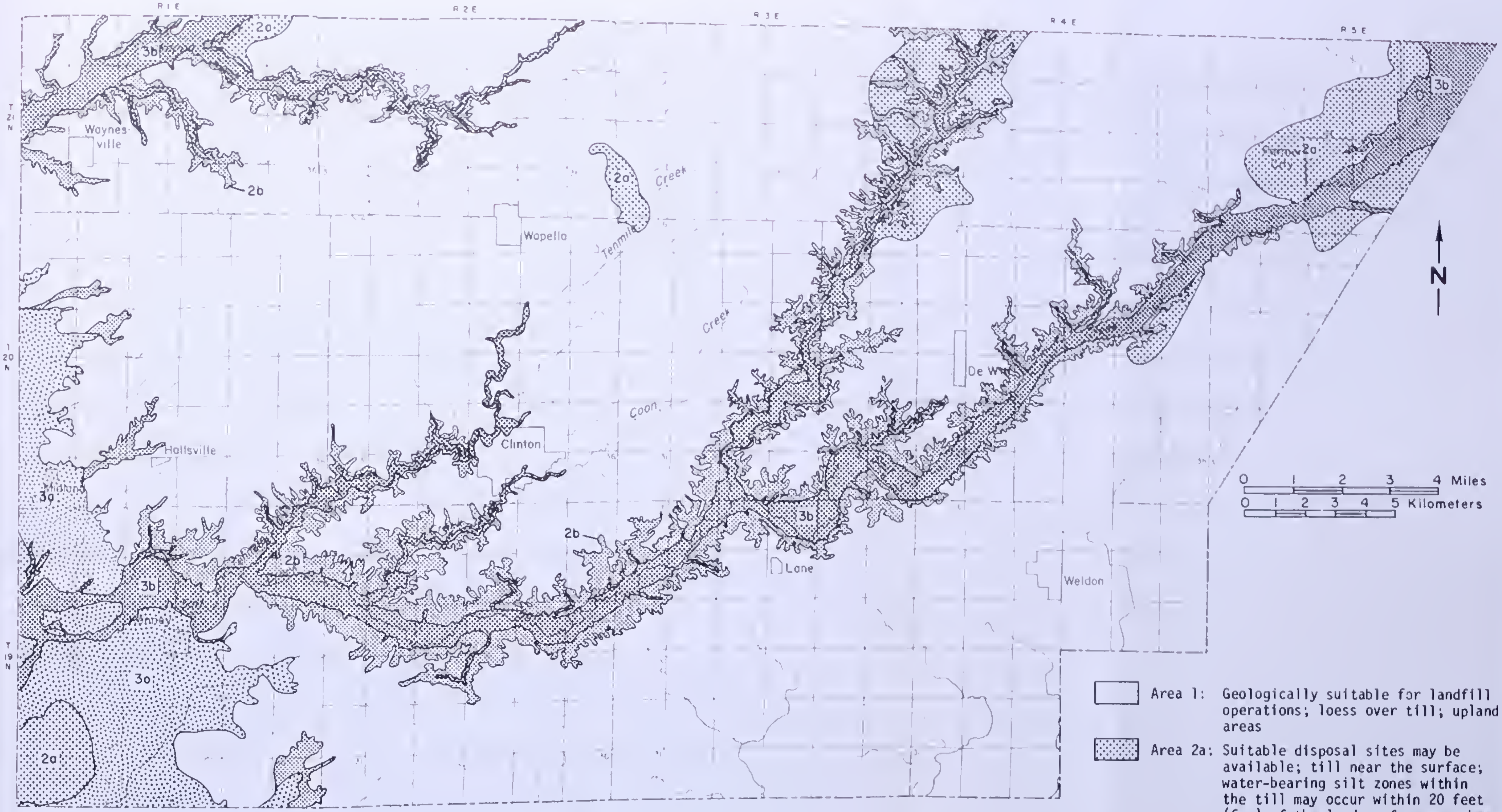

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▨ Area 3b: Generally unsuitable for landfill operations; shallow sand and gravel deposits and flowing streams

Geologic conditions for solid-waste disposal, De Witt County, Illinois

Figure 14

terraces. Free water flowing through the sands and gravels and generally wet conditions may result in seepage, caving of excavations, and low bearing capacities (table 2), making this area unsuitable for construction.

Glacial till forms moderate-to-steep slopes up to 50 feet (15 m) high along parts of the stream valleys (coded *Gmc(t)/Gsm(t)* in figure 15). Loam and clay loam tills may have high bearing strengths because of a lowered water table (table 2) and good drainage near the valley walls. Loess on these slopes is thin to absent. Thin lenses of silt and sand in the till, frequently within a depth of about 15 feet (4.6 m), may carry water and thus cause wet areas, slumping of slopes, covering of excavations, and lowered bearing capacities. The till is a workable material, easily excavated, and generally suitable for borrow unless very silty.

In the southwestern corner of the county, deposits of sand and gravel outwash are covered by 8 to 10 feet (.24 to 3 m) of loess and underlain by loam till (coded *Wm/Asg/Gsm(t)* in figure 15). Low-to-medium bearing capacities (table 2) and drainage problems may be encountered in the thick loess. Loess-covered surfaces in this level terrain are susceptible to frost heave and erosion by wind. Medium-to-high bearing capacities are encountered below a depth of 10 feet (3 m). Construction materials are readily available in this area, but water in the sediments may cause caving of excavations. Silt layers up to 5 feet (1.5 m) thick are above the till and below the outwash. These silts may have seepage problems and lower bearing strengths.

Most of De Witt County is covered by clay loam till overlain by a thin blanket of loess (*Wm/Gmc(t)* in figure 15). In spite of poor drainage and low bearing capacities in areas of thick loess accumulation or depressional areas, bearing capacities over most of the area are high (table 2). In excavations some seepage may be expected at the contact of loess and till. Discontinuous loose sands containing free water occur frequently within about 15 feet (4.6 m) below the top of the till. Except where it is very silty, the till is a good source of borrow material; it is workable and easily excavated. The level-to-gently-rolling upland of the till plain and the Shelbyville Morainic System provides generally good conditions for construction. Where continuous thin silt beds occur within 20 feet (6 m) of the surface, however, they may cause lowered bearing capacities and seepage problems.

The damming and subsequent flooding of Salt Creek and North Fork will change the hydrogeology of the affected deposits. Wave action will easily erode unprotected sand and silt deposits and thus cause failure of the banks. Unstable conditions along the shoreline may also develop from increased pore water pressure of the soil materials.

Detailed information on the engineering properties of the soils in De Witt County is available in the University of Illinois Engineering Experiment Station Bulletin 505, *Engineering Soil Report* (Thornburn, Liu, and Misiaszek, 1970).

Floods. All the streams in De Witt County are subject to seasonal flooding. Flash flooding may occur after heavy rains, as in the record flood on Salt Creek and its tributaries in May 1968 (Wilbourn, 1977). Maps of flood-prone areas for most of De Witt County can be obtained from the United States Geological Survey. Information on floodplain studies in De Witt County is available from the Hydrology Section of the Illinois State Water Survey. The Federal

TABLE 2

Engineering characteristics of surficial materials in De Witt County, Illinois[a]

KEY TO MAP AREA (fig. 15)	GEOLOGIC EQUIVALENT	SLOPE	DEPTH TO BEDROCK	THICKNESS (ft)	BEARING CAPACITY	SUSCEPTIBILITY TO FROST HEAVE	SUSCEPTIBILITY TO EROSION	FLOODING	WATER TABLE
Asm	Cahokia Alluvium	level	very deep	5 to 15	low	low to high	low to high	seasonal	high
Asg	Henry Formation			0 to 10	medium to high	medium to high	high in cuts		
Gmc(t)	Wedron Formation			0 to 10	high	low	low in cuts		
Gsm(t)	Glasford Formation			0 to 15	high	low	low in cuts		
Wm	Peoria Loess	gentle to moderate	very deep	3 to 5	low to medium	high	high in cuts and on slopes	occasional	medium to high
Asg	Henry Formation			0 to 18	medium to high	medium to high	high in cuts		
Gmc(t)	Wedron Formation			0 to 18	high	low	low in cuts		
Gmc(t)	Wedron Formation	moderate to steep	very deep	20 20	high	medium to high	medium to high in cuts	not likely	low to medium
Gsm(t)	Glasford Formation			0 to 20	high	medium to high	low in cuts		
Wm	Peoria Loess	level to gentle	very deep	8 to 10	low to medium	high	high in cuts and on slopes	not likely	high
Asg	Henry Formation			0 to 5	medium to high	medium to high	high in cuts		
Gsm(t)	Glasford Formation			5 to 12	high	low	low in cuts		
Wm	Peoria Loess	level to gentle	very deep	4 to 8	low to medium	high	high in cuts and on slopes	not likely	high
Gmc(t)	Wedron Formation			12 to 16	high	medium to high	medium to high in cuts		

[a] Data used in preparation of the above were derived from 154 logs of borings provided by the Illinois State Geological Survey, Commonwealth Edison, the Illinois Department of Transportation, and Dames and Moore.

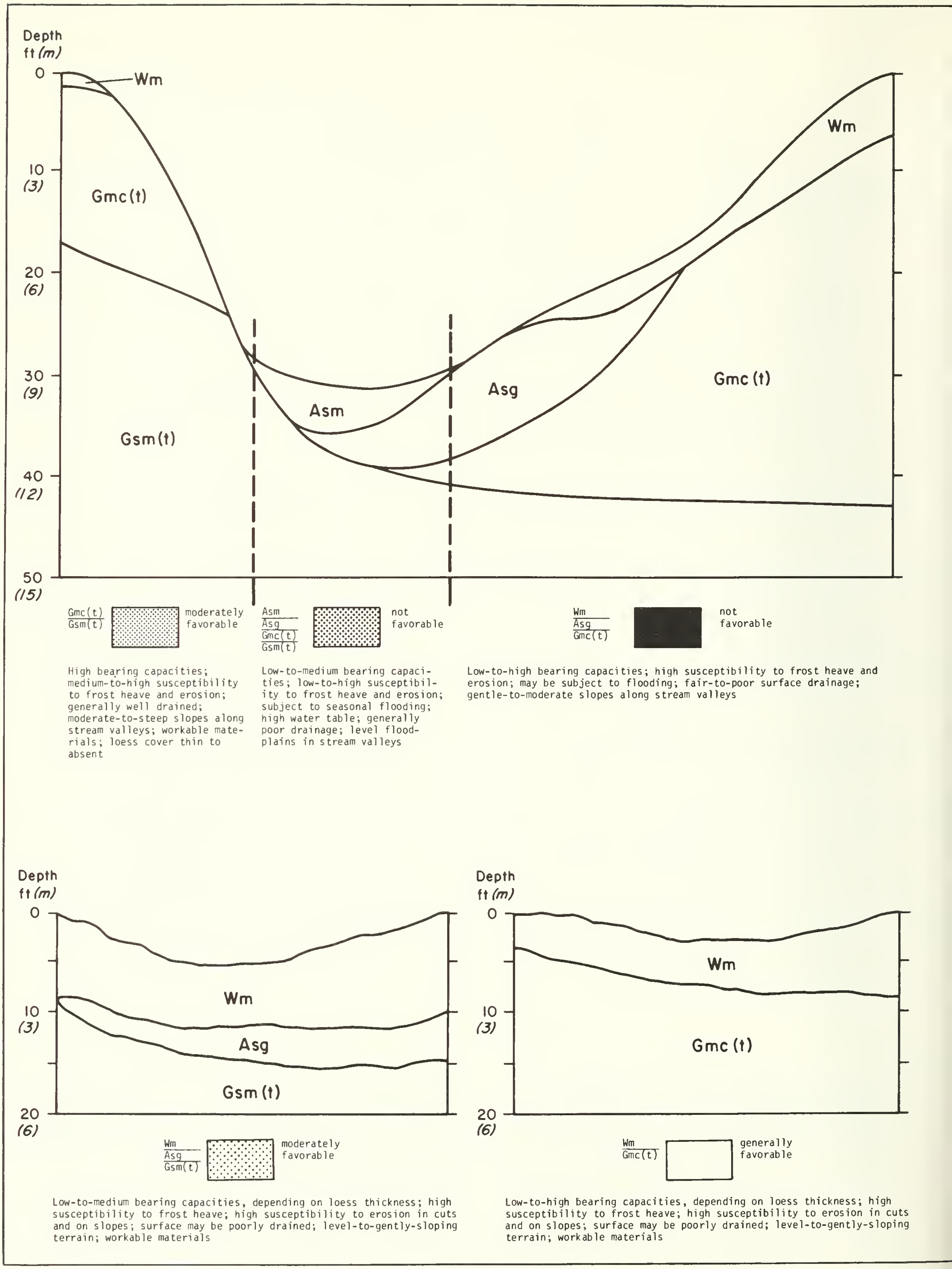
[b] USDA Textural class names; see appendix 2 for explanation.

Insurance Administration of the Department of Housing and Urban Development and the Illinois Department of Transportation, Division of Water Resources, Bureau of Local Assistance, are sources of information on the Flood Insurance Program available to those who own buildings on floodplains.

Seismicity. The De Witt County area has experienced little seismic activity. Seismic risk maps for the conterminous United States (e.g., Algermissen, 1969) show that the area would probably suffer only minor damage from a future earthquake. The epicenter of any earthquake would likely be far from De Witt County.

SURFACE DRAINAGE	PERMEABILITY	NATURAL MOISTURE CONTENT (% water, dry wt.)	COMPREHENSIVE STRENGTH		GRAIN SIZE (%)			MATERIAL TYPE[b]	SUITABILITY FOR CONSTRUCTION
			N (blows)	qu (tons/ft^2)	Sand (>.063 mm)	Silt (.063-.002 mm)	Clay (<.002 mm)		
poor	variable	22 to 37	2 to 7	0.4 to 1.0	variable	variable	variable	alluvial clays, silts, sand and gravel	not favorable
	variable	variable	variable	variable	variable	variable	variable	sandy loam to sand and gravel	
	medium	11 to 15	10 to 20	3.0 to 5.0	30 to 36	29 to 34	29 to 35	clay loam till	
	medium	12	22	5.0	44	29	27	loam till	
fair to poor	medium	25 to 33	2 to 6	0.4 to 1.0	2	70	28	silty clay loam	not favorable
	variable	variable	variable	variable	variable	variable	variable	sandy loam to sand and gravel	
	medium	11 to 15	10 to 20	3.0 to 5.0	30 to 36	29 to 34	29 to 35	clay loam till	
good	medium to low	11 to 15	10 to 20	3.0 to 5.0	30 to 36	29 to 34	29 to 35	clay loam till	moderately favorable
	medium	12	22	5.0	44	29	27	loam till	
poor	medium	25 to 33	2 to 6	0.4 to 1.0	2	70	28	silty clay loam	moderately favorable
	variable	variable	variable	variable	variable	variable	variable	sandy loam to sand and gravel	
	medium	12	22	5.0	44	29	27	loam till	
poor	medium	25 to 33	2 to 6	0.4 to 1.0	2	70	28	silty clay loam	generally favorable
	medium	11 to 15	10 to 20	3.0 to 5.0	30 to 36	29 to 34	29 to 35	clay loam till	

Perhaps the greatest seismic risk for De Witt County is a recurrence of the great earthquake sequence of 1811-1812, whose epicenter was near New Madrid, Missouri, 250 miles to the south. The first of three main shocks in the sequence occurred December 16, 1811, with a magnitude estimated at 7.2. In De Witt County, the intensity of the first shock was estimated to be between VI and VII on the modified Mercalli Intensity Scale, which defines intensity VIII as the lowest intensity at which serious damage to manmade structures occurs (Nuttli, 1973).



Gmc(t) / Gsm(t) ▨ moderately favorable

High bearing capacities; medium-to-high susceptibility to frost heave and erosion; generally well drained; moderate-to-steep slopes along stream valleys; workable materials; loess cover thin to absent

Asm / Asg / Gmc(t) / Gsm(t) ▨ not favorable

Low-to-medium bearing capacities; low-to-high susceptibility to frost heave and erosion; subject to seasonal flooding; high water table; generally poor drainage; level floodplains in stream valleys

Wm / Asg / Gmc(t) ■ not favorable

Low-to-high bearing capacities; high susceptibility to frost heave and erosion; may be subject to flooding; fair-to-poor surface drainage; gentle-to-moderate slopes along stream valleys

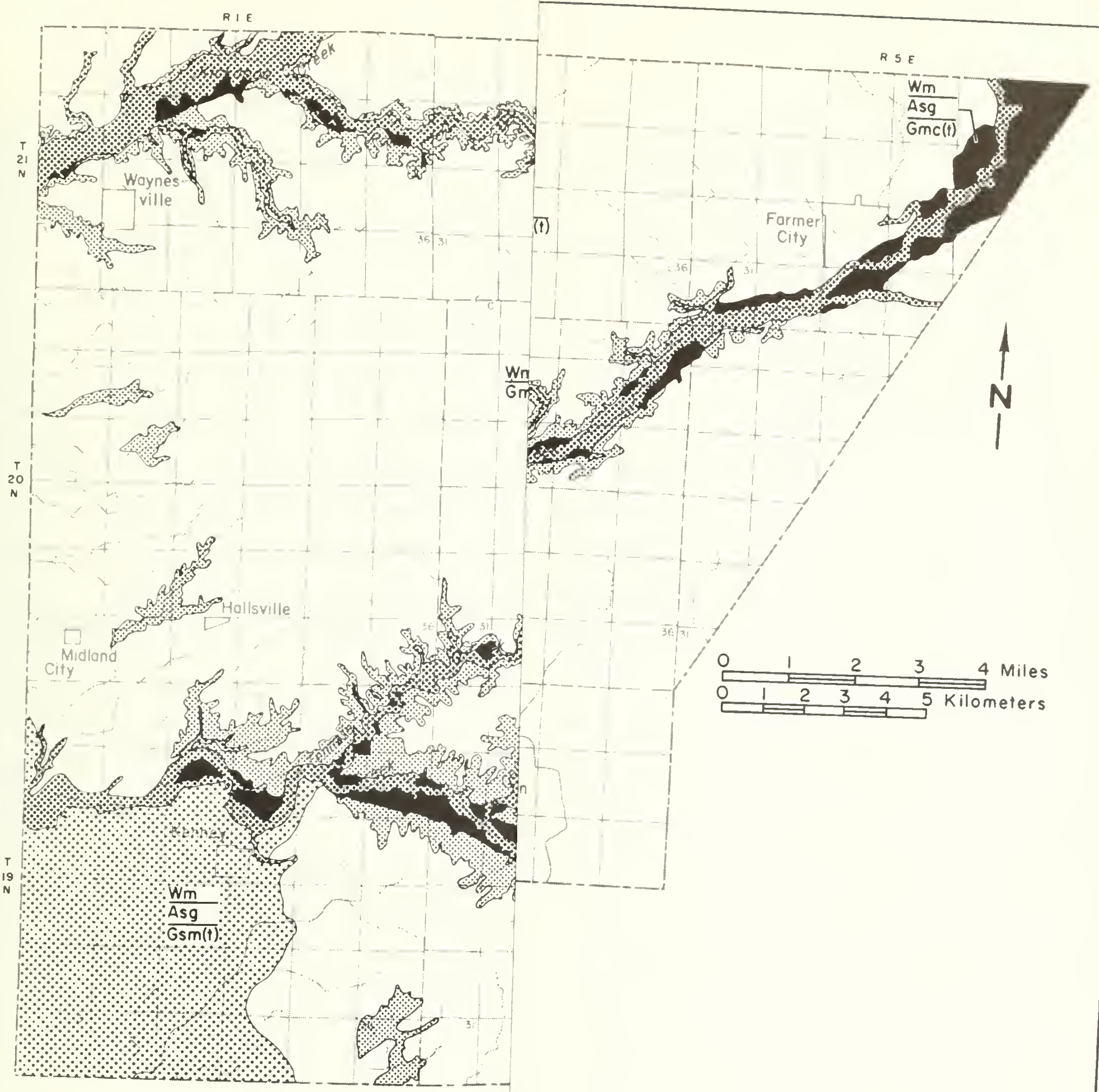
Wm / Asg / Gsm(t) ▨ moderately favorable

Low-to-medium bearing capacities, depending on loess thickness; high susceptibility to frost heave; high susceptibility to erosion in cuts and on slopes; surface may be poorly drained; level-to-gently-sloping terrain; workable materials

Wm / Gmc(t) ☐ generally favorable

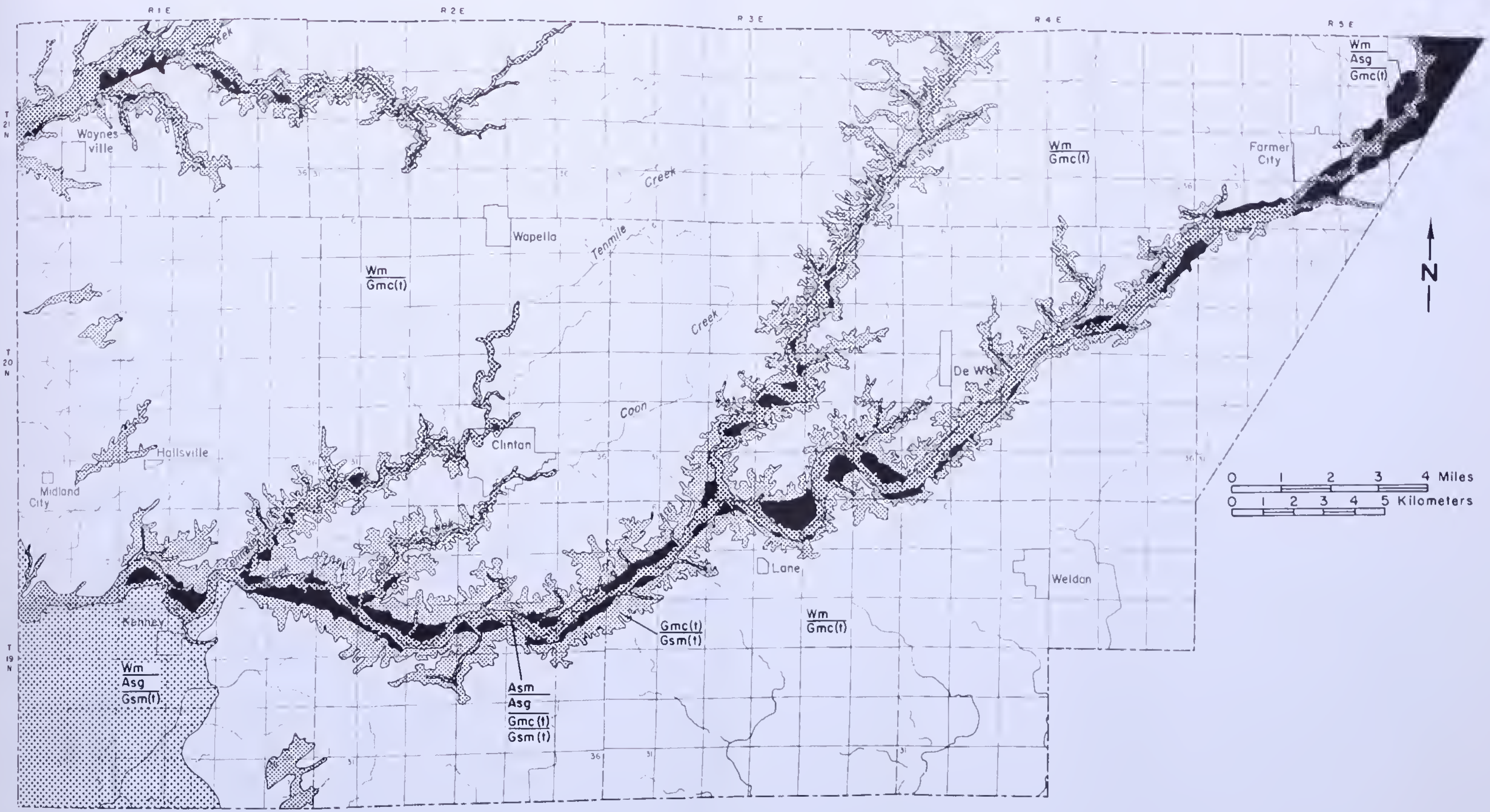
Low-to-high bearing capacities, depending on loess thickness; high susceptibility to frost heave; high susceptibility to erosion in cuts and on slopes; surface may be poorly drained; level-to-gently-sloping terrain; workable materials

Figure 15a



Geologic conditio
De Witt County,

Figure 15b



Geologic conditions for construction, De Witt County, Illinois

Figure 15b

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Appendix 1

Engineering geology map symbols

The following system of engineering geology map symbols was used in preparing figures 15a and 15b. The system was introduced by Richard W. Galster (1975) of the U.S. Army Corps of Engineers at the 18th Annual Meeting of the Association of Engineering Geologists in November 1975. Some modifications made by Paul DuMontelle are indicated by *.

Overburden Map Symbols

The basic symbol consists of a single capital letter representing the genetic symbol followed by a lower-case letter or letters depicting materials with reference to grain size. These may be followed by qualifying descriptive symbols in parentheses or mappable units designated by Arabic numbers following a hyphen.

Genetic Symbols (upper-case letters)

A	Alluvial
C	Colluvial
L	Lacustrine
G	Glacial
R	Residual
W	Aeolian
M	Marine
V	Volcanic
H	Human activities*

Material Symbols (lower-case letters)

c	clay
m	silt
s	sand
g	gravel and cobbles
p	organic material/peat
r	rock rubble
b	boulders
d	debris

Qualifying Symbols (always lower-case letters shown in parentheses)

(t)	till
(ta)	talus
(o)	outwash*
(u)	uncompacted spoil*
(c)	compacted fill*
(e)	excavation or cut
(mf)	mud flow
(ls)	landslide
(ic)	ice contact*

Bedrock Symbols

Bedrock symbols are formed by two capital letters representing the first two letters of the rock name or by other commonly used two-letter abbreviations. Examples: BA (basalt), SS (sandstone), LS (limestone), GR (granite).

Appendix 2

Definitions of engineering characteristics

SLOPE

Slope is a term denoting the vertical rise in feet per 100 feet of horizontal distance predominating within each unit.

TERM USED IN THIS REPORT	USDA DESIGNATION	ANGLE OF SLOPE (degrees)	PERCENT SLOPE (ft/100 ft)
Level to depressional	A	0 to 1	0 to 2
Gentle	B, C, D	1 to 9	2 to 15
Moderate	E	9 to 11	15 to 20
Steep	F	> 11	> 20

ENGINEERING PROPERTIES AND CLASSIFICATION OF SURFICIAL DEPOSITS

Bearing capacity of clayey soils (after Terzaghi and Peck, 1967)

TERM USED IN THIS REPORT	RELATIVE STRENGTH	FIELD TEST	UNCONFINED COMPRESSIVE STRENGTH (tons/ft^2)	STANDARD PENETRATION TEST, BLOW COUNT[a]
Low	Very soft	Easily penetrated several inches by fist	0.25	2
	Soft	Easily penetrated several inches by thumb	0.25 to 0.50	2 to 4
Medium	Medium	Penetrated several inches by thumb with moderate effort	0.50 to 1.00	4 to 8
	Stiff	Readily indented by thumb but penetrated only with great effort	1.00 to 2.00	8 to 15
High	Very stiff	Readily indented by thumbnail	2.00 to 4.00	15 to 30
	Hard	Indented with difficulty by thumbnail	> 4.00	> 30

[a] Blow count for 12-in. penetration (140-lb hammer; drop of 30 in.)

Susceptibility to frost heave

Susceptibility to frost heave depends primarily upon the percentage of fine-grained particles in the surficial materials.

TERM USED IN THIS REPORT	U.S. ARMY CORPS OF ENGINEERS FROST GROUP	TYPE OF MATERIAL
Low	F1	sand and gravel
Medium	F2, F3	mixtures of sand, silt, and gravel
High	F4	silty sands and tills, silts, clays, or any material with a high proportion of fines

Susceptibility to erosion

Erosion is the removal of a material by wind or water. Susceptibility to erosion depends upon the slope of the ground, the cohesive strength of the materials, and the density of vegetation in the area.

TERM USED IN THIS REPORT	SLOPE	COHESIVE STRENGTH	VEGETATION DENSITY
Low	level	high	high
Medium	moderate	medium	medium
High	steep	low	low

HYDROLOGIC CONDITIONS

Flooding

Not likely: Frequency less than once in 25 years
Occasional: Frequency once in one to 25 years
Seasonal: Frequency one or more times per year

Water table (depth most of year)

High to surface: 0 to 10 feet (0 to 3 m) above basement level
Medium: 10 to 15 feet (3 to 4.5 m) near basement level
Low: > 15 feet (> 4.5 m) below basement level

Permeability

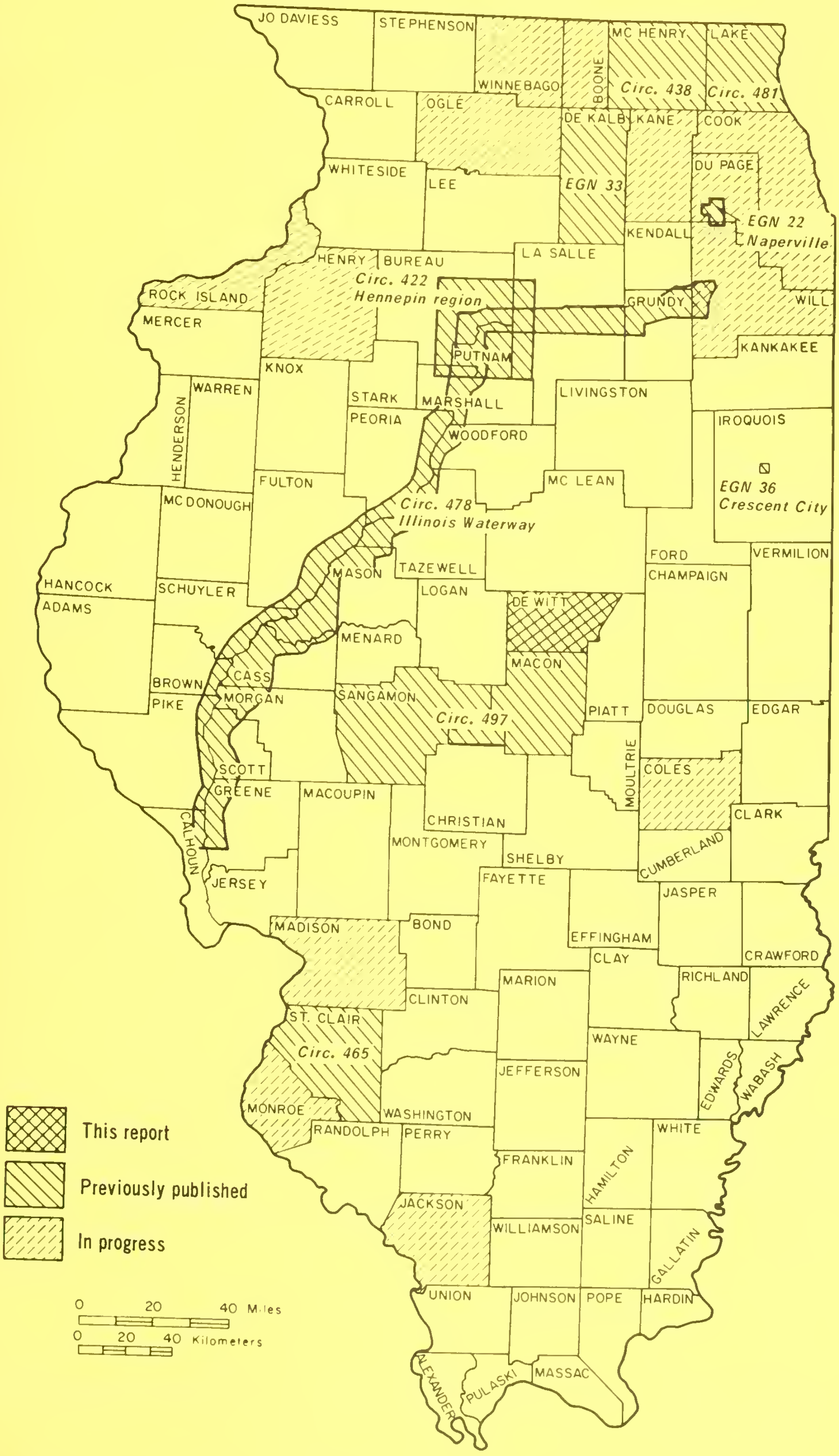
Permeability is the relative ease with which a material is capable of transmitting water.

TERM USED IN THIS REPORT	CM/SEC	MATERIALS
Low	$< 10^{-5}$	silty and clayey tills, silts, clays, and fine-grained organic materials
Medium	10^{-3} to 10^{-5}	fine sands and silty sands and gravels
High	$> 10^{-3}$	clean sands and gravels

TEXTURAL CLASS NAMES

Material type is classified according to a modified USDA textural classification (sand, 2.0 to 0.62 mm; silt, 0.62 to 0.004 mm; clay, <0.004 mm) (USDA, 1951).

	PERCENTAGES			
TEXTURE CLASS	Sand	Silt	Clay	Examples
Sand	> 85	< 15	< 10	90-6-4
Loamy sand	70-90	< 30	< 15	85-10-5 or 80-12-8
Sandy loam	43-85	< 50	< 20	75-15-10 or 50-45-5
Sandy clay loam	45-80	< 28	20-35	65-10-25
Clay loam	20-45	15-53	27-40	32-33-35
Sandy clay	45-65	< 20	35-55	45-10-45
Loam	23-52	28-50	7-27	45-40-15
Silt loam,	20-50	50-80	12-27	25-55-20
or	—	50-80	< 12	15-75-10
Silt	—	> 80	< 12	5-90-5
Silty clay loam	< 20	40-73	27-40	10-55-35
Silty clay	< 20	40-60	40-60	10-40-50
Clay	< 45	< 40	> 40	10-30-60



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